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

19th Winter Meeting Program

San Diego, California
December 2-6, 1990

Pebble Beach, California
December 6-8, 1990

Section on Pediatric Neurological Surgery of the American Association of Neurological Surgeons

19th Annual Meeting

San Diego Marriott Hotel & Marina
San Diego, California
December 2 -- 8, 1990

Pebble Beach
December 6 - 8, 1990

The Joint Committee on Education of the American Association of Neurological Surgeons and the Congress of Neurological Surgeons designates this continuing medical education activity for 20 credit hours (for the San Diego Meeting and 8 credit hours for the Pebble Beach Meeting) in Category I toward the Continuing Education Award in Neurosurgery and the Physician's Recognition Award of the American Medical Association. The Joint Committee on Education of the American Association of Neurological Surgeons and the Congress of Neurological Surgeons is accredited by the Accreditation Council for Continuing Medical Education to sponsor continuing medical education for physicians.

Program Summary

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
Frank Nulsen--1985
William F. Meacham--1986
Dale Johnson--1987
Joseph Volpe--1988
Martin Eichelberger--1989

Schulman Award

Kim Manwaring--1983
Neonatal Post-hemorrhagic Ventriculomegaly:
Management with Pulsed Lumbar Cisternostomy

Arno Fried--1984
A Laboratory Model of Shunt Dependent
Hydrocephalus

Anne Christine Duhaime--1985
The Shaken Baby Syndrome

Robert E. Breeze--1986
CSF Formation in Acute Ventriculities

Marc R. Del Bigio--1987
Shunt-induced Reversal of Periventricular
Pathology in Experimental Hydrocephalus

Scott Falci--1988
Rear Seatlap belts.
Are They Really 'Safe' for Children?

James M. Herman--1989
Tethered Cord As a Cause of Scoliosis in Children
With A Myelomeningocele

Pediatric Section Chairperson

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--1985-87
David G. McLone--1987-89
Donald H. Reigel--1989-90

Pediatric Annual Meeting Sites

Cincinnati	1972	San Francisco	1982
Columbus	1973	Toronto	1983
Los Angeles	1974	Salt Lake City	1984
Philadelphia	1975	Houston	1985
Toronto	1976	Pittsburgh	1986
Cleveland	1977	Chicago	1987
Philadelphia	1978	Scottsdale	1988
New York	1979	Washington	1989
New York	1980	San Diego & Pebble Beach	1990
Dallas	1981		

Acknowledgements

The Section on Pediatric Neurological Surgery of the American Association of Neurological Surgeons gratefully recognizes the support of the following exhibitors for the 1990 Pediatric Annual Meeting.

Acra-Cut, Inc. - Acton, Massachusetts
Baxter V. Mueller Division - McGaw Park, Illinois
Camino Laboratories, Inc. - San Diego, California
Codman & Shurtleff, Inc. - Randolph, Massachusetts
Cordis Corporation - Miami, Florida
Elekta Instruments, Inc - Tucker, Georgia
Hydrocephalus Foundation - San Francisco, California
Midas-Rex Instruments - Fort Worth, Texas
P.S. Medical - Goleta, Georgia
Radionics Sales Corp - Burlington, Massachusetts
Wild Leitz USA, Inc. - Rockleigh, New Jersey

This meeting has also received support from the Foundation for Pediatric and Laser Neurosurgery, Inc., San Diego for co-sponsoring guest speakers and administrative support.

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

Program of the Pediatric Section 19th Winter Meeting

American Association of Neurological Surgeons

San Diego Meeting
December 2 - 6, 1990

Pebble Beach Meeting Continuation
December 6 - 8, 1990

SUNDAY, DECEMBER 2, 1990

6:00 pm - 8:00 pm
Reception and Early Registration - Bayview Room

MONDAY, DECEMBER 3, 1990

7:00 am - 7:30 am
Registration
COFFEE AND EXHIBITS - Marina Foyer

8:00 am - 8:10 am
Opening Remarks - Donald H. Reigel, MD, Chairman,
Organizational Remarks - Hector E. James, MD,
Scientific Program Chairman

* Indicates Resident Paper

7:45 am - 8:30 am
ANNUAL PAOLO RAIMONDI LECTURE
George R. Leopold, MD, Professor and Chairman, Department of Radiology, School of Medicine, University of California San Diego.

8:30 am - 9:15 am
SCIENTIFIC SESSION I - Marina Ballroom

PERINATAL NEUROSURGERY: PATHOLOGY, DIAGNOSIS AND MANAGEMENT - Moderator:
Donald H. Reigel, M.D.

8:30 am - 8:40 am
1. "The Value of Prenatal Ultrasound in Predicting Early Outcome in Infants with Myelomeningocele". P.A. Aronin, MD, C.G. Brumfield, MD, D. Parrot, G.A. Cloud, MD, R.O. Davis, MD, Birmingham, AL

8:40 am - 8:50 am
*2. "Long-term Follow-up in Fetal Hydrocephalus: Diagnosis and Treatment Considerations". G.L. Rousseau, MD, D.C. McCullough, MD, A. Clayton, Washington, DC

8:50 am - 9:00 am
3. "Surgical Treatment and Long-term Neurodevelopmental Outcome in Idiopathic Aqueductal Stenosis". A. Shaaban, BS, W.C. Hanigan, MD, PhD

9:00 am - 9:15 am
OPEN DISCUSSION - Discussant:
G.R. Leopold, MD

9:15 am - 10:20 am
SCIENTIFIC SESSION II - Marina Ballroom

CRANIOSYNOSTOSIS AND CRANIOFACIAL ANOMALIES - Moderator:
R.P. Humphreys, MD

9:15 am - 9:25 am
4. "Simple Early Synostosis Operations". J. Shillito, MD, Boston, MA

9:25 am - 9:35 am
5. "Management of Coronal Synostosis in Early Infancy". S.T. Myles, MD, MSc., Calgary, Alberta

9:35 am - 9:45 am
6. "Trigonocephaly: Surgical Considerations and Long-term Follow-up". S.J. Schneider, MD, B.M. Greenberg, MD, A.D. Rosenthal, MD, A.H. Harris, MD, New Hyde Park, NY

9:45 am - 9:55 am
7. "Surgical Management of Syndromic versus Non-Syndromic Bilateral Coronal Synostosis". P.C. Francel, MD, Phd, J.A. Persing, MD, J.A. Jane, MD, PhD, Charlottesville, VA

9:55 am - 10:05 am
OPEN DISCUSSION - Discussant:
D.G. McLone, MD, PhD

10:05 am - 10:15 am
8. "Intraoperative ICP Monitoring in Craniosynostosis: A Preliminary Report". L.W. Solomon, MD, E. Ruas, MD, St. Petersburg, FL

10:15 am - 10:20 am
OPEN DISCUSSION - Discussant:
H.E. James, MD

10:20 am - 11:00 am
EXHIBITS, SNACKS AND REFRESHMENTS - Marina Foyer

11:00 am - 1:00 pm
SESSION III - Marina Ballroom

ASPECTS OF DEFORMATIONS AND MALFORMATIONS - Moderator:
H.E. James, MD

11:00 am - 11:15 am
GUEST MINI LECTURE:
"Deformations and Malformations in the Perinatal Period: Dysmorphology and Neurological Surgery". K.L. Jones, MD, Chief Division of Dysmoprhology, Department of Pediatrics, UCSD School of Medicine.

11:15 am - 11:45 am
GUEST MINI LECTURE:
"Craniofacial Syndromes: Recognizing Their Clinical Significance". M.C. Jones, MD, Chief of Dysmorphology and Genetics, Children's Hospital San Diego.

11:45 am - 11:55 am
9. "Development of the Harlequin Deformity in Unilateral Coronal Synostosis". J.B. Delashaw, Jr., MD, J.A. Persing, MD, C. Luce, J.A. Jane, MD, PhD, Gainesville, FL

11:55 am - 12:00 pm
OPEN DISCUSSION - Discussant:
K.L. Jones, MD

12:00 pm - 12:10 pm
*10. "Histochemical Analysis of Calvarial Sutures: New Insights on Skull Growth and Etiology of Craniosynostosis". M.J. Burke, DVM, MD, K.R. Winston, MD, Denver, CO

12:10 pm - 12:15 pm
OPEN DISCUSSION - Discussant:
M.C. Jones, MD

12:15 pm - 12:30 pm
11. "Organization of Craniocaudal Neuroaxial Levels during Induction of the CNS in an Experimental Model". M.S. Dias, MD, G.C. Schoenwolf, PhD, M.L. Walker, MD, Salt Lake City, UT

12:30 pm - 12:40 pm
12. "Cryomicrosection of a Twenty Week Gestation fetus Myelomeningocele". J.R. Ruge, MD, D.G. McLone, MD, PhD, Park Ridge, IL

12:40 pm - 12:50 pm
13. "The Cause of Chiari II Malformation". D.G. McLone, PhD, Chicago, IL

12:50 pm - 1:00 pm
OPEN DISCUSSION - Discussant
K.L. Jones, MD

2:00 pm
BUSES DEPART FOR SAN DIEGO ZOO AND BANQUET

TUESDAY, DECEMBER 4, 1990

7:00 am - 7:30 am
COFFEE AND EXHIBITS - Marina Foyer

1:00 p.m. - 2:30 p.m.
SCIENTIFIC SESSION IV - Marina Ballroom

HYDROCEPHALUS - BASIC RESEARCH - Moderator:
D.G. McLone, MD, PhD

7:30 am - 7:40 am
14. "Effects of Experimental Infantile Hydrocephalus and VP Shunts on Motor Cortex Connections". J.P. McAllister, PhD, J.S. Way, PhD, S.D. Katz, BS, Philadelphia, PA

7:40 am - 7:50 am
15. "Effects of Experimental Infantile Hydrocephalus and VP Shunts on CBF and SSEP". U.S. Vasthare, PhD, J.P. McAllister, PhD, R.F. Tuma, PhD, R.H. Rosenwasser, MD, P.M. Hale, BS, Philadelphia, PA

7:50 am - 8:00 am
OPEN DISCUSSION - Discussant:
D.H. Reigel, MD

8:00 am - 8:10 am
16. "High Energy Phophate Metabolism in Neonatal Hydrocephalus". J.M. Drake, MD, M. da Silva, MD, A. Mock, S.D. Michowiz, MD, U.I. Tuor, Toronto, Canada

8:10 am - 8:20 am

*17. "Regional Distribution of CBF in Neonatal Hydrocephalus". S.D. Michowiz, MD, A. Mock, U.I. Tuor, J.M. Drake, MD, Toronto, Canada

8:20 am - 8:30 am

18. "Effects of 8-(p-sulfophenyl) theophylline on pial arteriolar diameter during hypotension in piglets". T.S. Park, MD, J.M. Gidday, PhD, E. Gonzales, St. Louis, MO

8:30 am - 8:40 am

OPEN DISCUSSION - Discussant:
L.N. Sutton, MD

8:40 am - 8:50 am

*19. "Basilar Pons Attracts its Cortical Innervation by Chemotropic Induction of Collateral Branch Formation". C.D. Heffner, MD, D.D.M. O'Leary, PhD, St. Louis, MO

8:50 am - 8:55 am

OPEN DISCUSSION - Discussant:
D.G. McLone, MD, PhD

8:55 am - 9:05 am

20. "Elevated Cortical Venous Pressure in Hydrocephalus". H.D. Portnoy, MD, M.E. Castro, J. Maeseka, Bloomfield Hills, MI

9:05 am - 9:10 am

OPEN DISCUSSION - Discussant:
F.H. Sklar, MD

9:10 am - 9:55 am

SCIENTIFIC SESSION V - Marina Ballroom

HYDROCEPHALUS - CLINICAL ASPECTS - Moderator:
B. Copeland, MD

9:10 am - 9:20 am

*21. "Hydrocephalus and the Chiari Malformation in Patients with Crouzon's and Apert's Syndrome". P.W. Francis, MD, S. Beals, MD. H.L. Rekate, MD, J. Reiff, RN, H.W. Pittman, MD, K.H. Manwaring, MD, Phoenix, AZ

9:20 am - 9:25 am

OPEN DISCUSSION - Discussant:
H.D. Portnoy, MD

9:25 am - 9:35 am

22. "Atrophy versus Hydrocephalus in Hurler's Syndrome". M.V. Shah, MD, S.J. Haines, MD, C.B. Whitely, MD, K. Belani, MBBS, W. Krivit, MD, Minneapolis, MN

9:35 am - 9:40 am

OPEN DISCUSSION - Discussant:
H.L. Rekate, MD

9:40 am - 9:50 am

23. "Ventriculopleural Shunting: Use as a Temporary Diversion". C.D. Willison, MD, H.H. Kaufman, MD, T.A. Koptnik, MD, R. Gustafson, MD, E. Jones, MD, PhD, Morgantown, WV

9:50 am - 9:55 am

OPEN DISCUSSION - Discussant:
A.E. Marlin, MD

9:55 am - 10:30 am
EXHIBITS, SNACKS, REFRESHMENTS - Marina Foyer

10:30 am - 12:35 pm
SESSION VI - Marina Ballroom

HYDROCEPHALUS: TECHNICAL ASPECTS AND COMPLICATIONS - Moderator:
W.R. Cheek, MD

10:30 am - 10:40 am
*24. "Effects of Subcutaneous Implantation on Anti-Siphon Device Function". M.C. da Silva, MD, J.M. Drake, MD, Toronto, Canada

10:40 am - 10:45 am
OPEN DISCUSSION - Discussant:
E.L. Foltz, MD

10:45 am - 10:55 am
*25. "Compensation Reversal After Shunting for Hydrocephalus". P. Roth, MD, A.R. Cohen, MD, Boston, MA

10:55 am - 11:00 am
OPEN DISCUSSION - Discussant:
F.H. Sklar, MD

11:00 am - 11:05 am
26. "Enlargement Cranioplasty for Treatment of Slit-Ventricle Syndrome". G.W. Hornig, MD, K. Winston, MD, Kansas City, MO

11:05 am - 11:10 am
OPEN DISCUSSION - Discussant:
J.W. Walsh, MD, PhD

11:10 am - 11:20 am
*27. "Multiloculated Hydrocephalus: Treatment with Craniotomy and Ventricular Fenestration". T. Nida, MD, S.J. Haines, MD, Minneapolis, MN

11:20 am - 11:30 am
28. "Endoscopic Features of Unilateral Obstructive Hydrocephalus". K.H. Manwaring, MD, Phoenix, AZ

11:30 am - 11:40 am
29. "Endoscopic Ventricular Surgery". A.R. Cohen, MD, C.B. Heilman, MD, Boston, MA

11:40 am - 11:50 am
OPEN DISCUSSION - Discussant:
M.L. Walker, MD

11:50 am - 12:00 pm
30. "Gram Negative CSF Shunt Infections". B.A. Kaufman, MD, J. Kim, MD, R. Yogev, MD, D.G. McLone, MD, St. Louis, MO

12:00 pm - 12:05 pm
OPEN DISCUSSION - Discussant:
H.E. James, MD

12:05 pm - 12:15 pm
31. "The Use of the Surgical Isolation Bubble System in Shunts". S.J. Gaskill, MD, A.E. Marlin, MD, Durham, NC

12:15 pm - 12:20 pm
OPEN DISCUSSION - Discussant:
R.M. Scott, MD

12:20 pm - 12:30 pm
32. "Complications of Ventriculoperitoneal Shunting for Hydrocephalus Associated with Vein of Galen Malformations in Childhood". S.J. Schneider, MD, J.S. Wisoff, MD, F. Epstein, MD, New Hyde Park, NY

12:30 pm - 12:35 pm
OPEN DISCUSSION - Discussant:
R.P. Humphreys, MD

2:00 pm
TENNIS AND GOLF TOURNAMENTS

WEDNESDAY, DECEMBER 5, 1990

7:00 am - 7:30 am
COFFEE AND EXHIBITS - Marina Foyer

7:30 am - 10:30 am
SESSION VII - Marina Ballroom

NEOPLASMS PART I - BASIC RESEARCH

SECTION I - ASTROCYTIC SERIES - Moderator:
A.E. Marlin, MD

7:30 am - 7:37 am
33. "Flow Cytometric Alanysis of Pleomorphic Xanthoastrocytomas". R.C. Rostomily, MD, J. Hoyt, MD, M.S. Berger, MD, P.S. Rabinovitch, MD, PhD, Seattle, WA

7:37 am - 7:44 am
34. "Cytogenic Findings in Pediatric Brain and Spinal Tumors". W.M. Chadduck, MD, J.R. Sawyer, PhD, Little Rock, AR

7:44 am - 7:51 am
*35. "Expression of Glial Specific Antigens and Growth Factor Expression in Glial Tumors of Varied Malignancy". B. Warf, MD, T. Mapstone, MD, Cleveland, OH

7:51 am - 7:58 am
36. "Proliferative Potential and Outcome in Glial Tumors of Childhood". M. Prados, MD, H.G.J. Krouwer, MD, M.S.B. Edwards, MD, T. Hoshino, MD, D.M.Sc., D. Ahn PhD, San Francisco, CA

8:00 am - 8:10 am
OPEN DISCUSSION - Discussant:
J.H. Wissoff, MD

PART 2 - PNET SERIES

8:10 am - 8:17 am
37 Expression of the Multiple Drug Resistance Gene, mdr1, by Pediatric PNET". D.M. Tishler, MD, C. Raffel, MD, PhD, Los Angeles, CA

8:17 am - 8:24 am
*38. "Induced Differentiation of Medulloblastoma in Tissue Culture: A Model to Study Differentiation and Oncogenesis". J. Ragheb, MD, P. Ebert, MD, J. Chandler, MSIV, M. Salcman, MD, Baltimore, MD

8:24 am - 8:31 am
39. "Cellular DNA Content is Predictive of Early Relapse in Medulloblastoma". R.A. Sanford, MD, E.C. Douglass, MD, Memphis, TN

8:31 am - 8:38 am
40. "The P53 Gene and PNET". C. Raffel, MD, PhD, D.M. Tishler, MD. L. Lopez, MS, L.S. Sender, MD, K.I. Weinberg, MD, Los Angeles, CA

8:40 am - 8:50 am
OPEN DISCUSSION - Discussant:
J.W. Walsh, MD, PhD

CLINICAL ASPECTS - Moderator:
G.A. Magid, MD

PART I - ASTROCYTIC SERIES

8:50 am - 8:57 am
41. "Late Presenting Aqueductal Stenosis". T.S. Berger, MD, W.S. Ball, MD, K.R. Crone, MD, E.C. Prenger DO, Cincinnati, OH

8:57 am - 9:04 am
42. "Collicular Plate Gliomas". W.R. Boydston MD, R.A. Sanford, MD, E. Kirk, RN, MSN, Memphis, TN

9:04 am - 9:11 am
43. "Intrinsic Tumors Confined to the Medulla: Results of Aggressive Surgical Treatment". R. Abbott, MD, F. Epstein, MD, J.H. Wisoff, MD, New York, NY

9:11 am - 9:20 am
OPEN DISCUSSION - Discussant:
J.W. Oakes, MD

9:20 am - 9:27 am
44. "Cerebellar Astrocytoma: Very Late Recurrence". A.L. Amacher, MD, Danville, PA

9:27 am - 9:34 am
45. "Gangliogliomas: A 13 year Review". S. Haddad, MD, A. Menezes, MD, J.C. Van Gilder, MD, Iowa City, IA

9:34 am - 9:40 am
OPEN DISCUSSION - Discussant:
J.G. McComb, MD

9:40 am - 9:50 am
Report of Ongoing Protocols in CCSG.
J.H. Wisoff, MD

9:50 am - 10:00 am
Report of Ongoing Protocols in POG.
R.A. Sanford, MD

10:00 am - 10:30 am
EXHIBITS, SNACKS AND REFRESHMENTS - Marina Foyer

10:30 am - 12:15 pm
SESSION VIII

NEOPLASMS (continued)

PART II - OTHER TUMORS - Moderator:
M.L. Walker, MD

10:30 am - 10:40 am
46. "Pituitary Adenomas in Childhood: Results of Transphenoidal Surgery". M.D. Partington, MD, D.H. Davis, MD, E.R. Laws, MD, Rochester, MN

10:40 am - 10:45 am
OPEN DISCUSSION - Discussant:
A.L. Amacher, MD

10:45 am - 10:52 am

47. "Prognostic Significance of Age and Degree of Surgical Resection of Ependymomas: The Boston Children's Hospital Experience". R. McL. Black, MD, PhD, E. Healey, N. Tarbell, P. Barnes, W. Kupsky, R.M. Scott, MD, S. Sallan, Boston, MA

10:52 am - 10:57 am

OPEN DISCUSSION - Discussant:
R.A. Sanford, MD

10:57 am - 11:07 am

*48. "Therapy of Cerebral PNET in Childhood". H.E. Fuchs, MD, W.J. Oakes, MD, H.S. Freidman, S.C. Schold, B. Hockenberger, E. Halperin, Durham, NC

11:07 am - 11:12 am

OPEN DISCUSSION - Discussant:
D.L. Johnson, MD

11:12 am - 11:22 am

49. "Craniopharyngiomas in Children: Long-term Follow-up and Treatment Methods". J. Anderson, MD, A. Fried, MD, J. Ahl, RN, J. Hahn, MD, Cleveland, OH

11:22 am - 11:29 am

50. "Fusiform Dilatation of the Carotid Artery Following Radical Surgery of Childhood Craniopharyngioma". L.N. Sutton, MD. D. Gusnard, MD, D. Bruce, MD., R.J. Packer, MD, R.A. Zimmerman, MD, Philadelphia, PA

11:29 am - 11:36 am

51. "Intracavitary Therapy for Cystic Brain Tumors in Children with 32P Chromic Phophate Colloid". J.A. Taren, MD, T.W. Hood, MD, B. Shapiro, MD, Ann Arbor, MI

11:36 am - 11:46 am

OPEN DISCUSSION - Discussant:
M.L. Walker, MD

11:46 am - 11:55 am

52. "The Development of Carcinoma in the Aging Myelodysplastic Population". S.J. Gaskill, MD, Durham, NC

11:55 am - 12:00 pm

OPEN DISCUSSION - Discussant:
J.O. Penix, MD

12:00 pm - 12:15 pm

FOREIGN PRESENTATION

"Surgical Management of Brainstem Tumors in Children, Review of 62 Operated Cases". A. Pierre-Kahn, MD, D. Renier, MD, C. Sainte-Rose, J.F. Hirsch, MD, Paris, France

12:15 pm

ADJOURN

12:30 pm - 1:30 pm

BUSINESS MEETING - Members Only

6:00 pm

COCKTAILS, ANNUAL BANQUET
GUEST SPEAKER:
Professor K. Bernischke, MD
"Endangered Species"

THURSDAY, DECEMBER 6, 1990

7:00 am - 7:30 am
COFFEE AND EXHIBITS - Marina Foyer

7:30 am - 10:15 am
SESSION IX - Marina Ballroom

TRAUMA

PART I - HEAD INJURY - Moderator:
T.G. Luerssen, MD

7:30 am - 7:40 am
53. "Head Injured Children Attending Emergency Rooms in Houston and Scotland". M.E. Miner, MD, B. Jennett, MD, R. Frankowski, MD, Columbus, OH

7:40 am - 7:45 am
OPEN DISCUSSION - Discussant:
L.F. Marshall, MD

7:45 am - 7:55 am
*54. "All-Terrain Vehicle Injuries". D.I. Levy, MD, J.M. Zambraski, MD, H.L. Rekate, MD, Phoenix, AZ

7:55 am - 8:00 am
OPEN DISCUSSION - Discussant:
T.G. Luerssen, MD

8:00 am - 8:10 am
*55. "Penetrating Craniocerebral Trauma and Gunshot Wounds in Children: A Report of 16 cases". L. Rogers, MD, A.D. Parent, MD, Jackson, MS

8:10 am - 8:15 am
OPEN DISCUSSION - Discussant:
L.F. Marshall, MD

8:10 am - 8:20 am
56. "Burst Fracture: Delayed versus Emergent Surgery". R.A. Sanford, MD, G. Ricca, MD, Memphis, TN

8:25 am - 8:35 am
*57. "Primary Repair of Open Depressed Skull Fractures with Bone Replacement". J.B. Blakenship, MD, W.M. Chadduck, MD, F.A. Boop, MD, Little Rock, AR

8:35 am - 8:40 am
OPEN DISCUSSION - Discussant:
Y.S. Hahn, MD

PART II - SPINE INJURY AND CLINICAL RESEARCH

8:40 am - 8:50 am
*58. "Custom Fitted Thermoplastic Minerva Jackets in the Treatment of Cervical Spine Instability in Preschool Age Children". S.J. Gaskill, MD, A.E. Marlin, MD, Durham, NC

8:50 am - 9:00 am
59. "Management of Axis Fracture in Very Young Children". Y.S. Hahn, MD, J. Ruge, MD, D.G. McLone, MD, M. Mandebach, MD, Maywood, IL

9:00 am - 9:10 am
*60. "Pediatric Spinal Injury". M. Hamilton, MD, S.T. Miles, MD, Calgary, Canada

9:10 am - 9:20 am

*61. "Neurological Outcome after Spinal Cord Injury Without Radiographic Abnormalities". C.A. Dickman, MD, J.M. Zambraski, MD, H.L. Rekate, MD, V.K.H. Sonntag, MD, Phoenix, AZ

9:20 am - 9:30 am

OPEN DISCUSSION - Discussant:
L.D. Cahan, MD

9:30 am - 9:40 am

62. "Intraoperative Measurement of Spinal Cord Blood Flow During Tethered Cord Release". S.J. Schneider, MD, A.D. Rosenthal, MD, B.M. Greenberg, MD, New Hyde Park, NY

9:40 am - 9:45 am

OPEN DISCUSSION - Discussant:
W.J. Peacock, MD

9:45 am - 10:15 am

EXHIBITS, SNACKS AND REFRESHMENTS - Marina Foyer

10:15 am - 12:00 pm

SESSION X - Marina Ballroom

EPILEPSY, DIAGNOSTIC STUDIES AND TREATMENT -
Moderator:
T.A. Waltz, MD

10:15 am - 10:25 am

63. "CT, MRI and the Pathological Substrate of Intractable Epilepsy in Childhood". G. Morrison, MD, A.R. Prats, MD, M.C. Penate, RN, Miami, FL

10:25 am - 10:35 am

64. "The Juvenile Diffuse AVM: A New Subtype of Vascular Malformation". L. Chin, MD, C. Raffel, MD, J.G. McComb, MD, I. Gonzalez-Gomez, MD, S. Giannotta, MD, Los Angeles, CA

10:35 am - 10:45 am

65. "Use of MR Angiography in Children". N.G. Asner, MD, W.C. Olivero, MD, W.C. Hanigan, MD, R.M. Wright, MD, Peoria, IL

10:45 am - 10:55 am

OPEN DISCUSSION - Discussant:
J.G. McComb, MD

10:55 am - 11:05 am

*66. "Preoperative Evaluation and Temporal Lobectomy in Children with Chronic Epilepsy". P.D. Adelson, MD, W.J. Peacock, MD, Y. Comair, MD, H. Vinters, MD, Los Angeles, CA

11:05 am - 11:15 am

67. "Multimodality Preoperative Evaluation of Children for Epilepsy Surgery". L.D. Cahan, MD, C.S. Greene, Jr., MD, P. Lubens, MD, Orange, CA

11:15 am - 11:30 am

OPEN DISCUSSION

11:30 am - 11:40 am

68. "Hemispheric Tumors in Children Associated with Epilepsy: Histopathology of Resected Seizure Foci". M.S. Berger, MD, G. Ojemann, MD, W. Pilcher, S. Ghatan, Seattle, WA

11:40 am - 11:50 am

69. "Epilepsy Surgery in Children with Brain Tumors". A. Fried, MD, J. Ahl, RN, E. Wyllie, MD, I. Awad, MD, J. Hahn, MD, Cleveland, OH

11:50 am - 12:00 pm
OPEN DISCUSSION

12:00 pm
CLOSING REMARKS - ADJOURN
Depart for Meeting Continuation in Pebble Beach

MEETING CONTINUATION PEBBLE BEACH

DECEMBER 6 - 8, 1990

THURSDAY, DECEMBER 6, 1990

7:00 pm - 8:00 pm
Welcoming Reception and Registration

FRIDAY, DECEMBER 7, 1990

7:00 am - 7:30 am
Registration and Opening Remarks

7:30 am - 11:30 am
Scientific Session

SATURDAY, DECEMBER 8, 1990

7:00 am - 11:00 am
Scientific Session

7:00 pm
Cocktails, Dinner and Closing Statements

FRIDAY, DECEMBER 7, 1990

7:30 am - 9:00 am
SESSION IX

CEREBROVASCULAR DISEASE, STEREOTAXIS AND GAMMA KNIFE

7:30 am - 7:45 am

1. "Pediatric Intracranial Aneurysms: Conventional and Specialized Treatments" - J.M. Herman, MD, H.L. Rekate, MD, R.F. Spetzler, MD, Phoenix, AZ

7:45 am - 8:00 am

2. "Arteriovenous Malformations in Childhood". T. Lasner, D. Heffez, MD, Chicago, IL

8:00 am - 8:15 am

3. "Staged Resection of Arteriovenous Malformations in Childhood and Adolescence". H.Z. Baldwin, MD, H.L. Rekate, MD, R.F. Spetzler, MD, Phoenix, AZ

8:15 am - 8:30 am

4. "Treatment of Intracranial AVM in Children Using the Gamma-Knife Surgery". J.H. Lee, MD, L. Steiner, MD, PhD, C. Lindquist, MD, M. Steiner, MD, Charlottesville, VA

8:30 am - 8:45 am

5. "The Current Role of Radiosurgery in Children and Adolescents". D. Kondiolka, MD. L.D. Lunsdord, MD. R.J. Coffey, MD, J.C. Flickinger, MD, Pittsburgh, PA

8:45 am - 9:00 am
DISCUSSION

9:00 am - 9:15 am
COFFEE BREAK

9:15 am - 10:15 am
SESSION X

NEOPLASMS - PART II

9:15 am - 9:30 am

6. Congenital Choroid Plexus Papillomas". M.J. Burke, DVM, MD, K.R. Winston, MD, Denver, CO

9:30 am - 9:45 am

7. "Radiation Associated Gliomas and Meningiomas in the Pediatric Population". T.R. Ridenour, MD, A.H. Menezes, MD, R.L. Schelper, MD, Iowa City, IA

9:45 am - 10:00 am

8. "Translabyrinthine Approach for and Anteriorly Extended Pontine Tumor". A. Pierre-Kahn, MD, J.F. Hirsch, MD, Paris, France

10:00 am - 10:15 am
DISCUSSION

10:15 am - 11:15 am
SESSION XI

INFECTIONS

10:15 am - 10:30 am

9. Subdural Empyema in Children". R. Michael, MD, F.A. Gutierrez, MD, Chicago, IL

10:30 am - 10:45 am

10. Loculated Subarachnoid Pus: A Complication of Childhood Meningitis". W.B. Faircloth, MD, W.O. Bell, MD, Winston-Salem, NC

10:45 am - 11:15 am

DISCUSSION

SATURDAY, DECEMBER 8, 1990

7:00 am - 11:00 am

SESSION XII

PERIPHERAL NERVES, RHIZOTOMIES, AND SPINAL PATHOLOGY

7:00 am - 7:30 am

11. Early Surgery for Birth Related Upper Brachial Plexus Injuries". J.P. Laurent, MD, S. Shenaq, MD, R. Lee, MD, J. Parke, MD, I. Solis, MD. L. Kowalik, RN, Houston, TX

7:30 am - 7:45 am

12. "Nerve Coaptation in an Infant with Cervical Nerve Root Avulsion". S. Yamada, MD, PhD, G. Peterson, MD, D. Knierim, MD, D. Will, MD, Loma Linda, CA

7:45 - 8:00 am

DISCUSSION

8:00 am - 8:15 am

13. "The Effect of Myelomeningocele Closure on Urinary Function in Neonates with Spina Bifida". W.O. Bell, MD, L. Kroovand, MD, L.J. Hart, MT, K.Y. Benfield, PAC, Winston-Salem, NC

8:15 am - 8:30 am

14. "Sacral Rhizotomy to Increase Bladder Capacity in Spinal Cord Injury (Animal Model)". J.V. Pattisapu MD, M.L. Walker, MD, N. Newberg, MD, J.C. Cheever, MD, B. Snow, MD, Orlando, FL

8:30 am - 8:45 am

15. "Selective Sacral Rhizotomy for Bladder Spasticity". B.B. Storrs, MD, W. Kaplan, MD, C. Filirt, MD. D.G. McLone, MD, PhD, Chicago, IL

8:45 am - 9:00 am

DISCUSSION

9:00 am - 9:15 am

COFFEE BREAK

9:15 am - 9:30 am

16. "Intraspinal Accumulation of Spinal Fluid Causing Cord Compression in Children with Myelodysplasia Secondary to Malfunctioning Ventriculoperitoneal Shunt". R.M. Beatty, MD, Kansas City, KS

9:30 am - 9:45 am

DISCUSSION

9:45 am - 10:00 am

17. "Silastic Duroplasty". W.M. Chadduck, MD, F.A. Boop, MD, Little Rock, AR

10:00 am - 10:10 am

DISCUSSION

10:10 am - 10:25 am

18. "Resolution of Scoliosis in Pediatric Chiari Malformations Without Myelodysplasia". M.G. Muhonen, MD, A.H. Menezes, MD, P.D. Sawin, B.S., Iowa City, IA

10:25 am - 10:35 am

DISCUSSION

10:35 am - 10:50 am

19. "Spinal Epidural Hematoma in a Hemophiliac Infant". L.P. Carter, MD, I. Noth, MSIII, J. Pittman, MD, Tucson, AZ

10:50 am - 11:00 am

DISCUSSION

11:00 am

ADJOURN

Scientific Abstracts

1. THE VALUE OF PRENATAL ULTRASOUND IN PREDICTING EARLY OUTCOME OF INFANTS WITH MYELOMENINGOCELE

P.A. Aronin, MD, C.G. Brumfield, D. Parrot, G.A. Cloud, R.O. Davis, (Birmingham, AL)

From August 1, 1986 through July 31, 1990, 25 fetuses with a myelomeningocele had serial ultrasound exams at our institution prior to Cesarean delivery. The last scan (within 2 weeks) prior to delivery was reviewed to see if there were any ultrasound findings such as the biparietal diameter (BPD), head circumference (HC), cerebral lateral ventricular size, the level and extent of the lesion, or the amniotic fluid volume that could predict the infant's hospital course during the first two months of life. Six fetuses (24%) were diagnosed antenatally with cephalomegaly (a BPD and HC > 95th percentile for gestational age) and these infants were noted to have had a longer mean hospital stay (42 days vs. 17 days), were more likely to need medical treatment for recurrent apnea and bradycardia (50% vs 21%), severe gastroesophageal reflex (50% vs 10%) and more often needed reintubation for ventilatory support while recovering from surgical closure of their defects (33% vs 5%). Conclusions: In this study the antenatal diagnosis of cephalomegaly identified a group of infants with myelomeningocele who were at increased risk for short term morbidity. Long term studies are needed to see if cephalomegaly is also associated with an increased risk of mental and/or neurologic impairment.

2. LONG-TERM FOLLOW-UP IN FETAL HYDROCEPHALUS: DIAGNOSIS AND TREATMENT CONSIDERATIONS

Gail L. Rosseau, MD, David C. McCullough, MD, Amy Clayton, (Washington, DC)

Advances in prenatal diagnostic ultrasonography have increased the frequency of detection of gestational hydrocephalus. Neurosurgeons may be confronted with requests for prognostic information in these cases. The authors have reviewed 56 cases of fetal hydrocephalus in an attempt to update the diagnostic picture for those patients referred for evaluation of in-utero hydrocephalus. Data on 40 patients was available for analysis. Three of the fetuses were electively aborted and 37 were delivered. Of those who came to delivery, 65% (24/37) were treated for neonatal hydrocephalus. Reasons for non-treatment included: inaccurate diagnosis, resolution of hydrocephalus by time of delivery, neonatal death and parental wishes.

Twenty-one of the treated survived with an average follow-up of 4 years (range 0.25-14 years). The survival of the 12 untreated patients with hydrocephalus ranged from 24 hours to 7 years for an average of 2.5 years. Survival in the 24 treated patients ranged from 0.25 to 14 years with an average survival of 4.25 years. Six of the shunted patients died within the first 28 months of life. The long-term functional capacity of treated and nontreated patients was assessed. Among shunted patients, normal motor function was found in 17% (4/24) and normal cognitive ability in 42% (10/24).

2. LONG-TERM FOLLOW-UP IN FETAL HYDROCEPHALUS: DIAGNOSIS AND TREATMENT CONSIDERATIONS (continued)

Among the 21 shunted survivors, good functional capacity appeared to be associated with cortical mantle thickness greater than 2 cm. Good cognitive functioning did not appear to be dependent upon absence of associated abnormalities. In particular, children with myelomeningocele and shunts did not have worse cognitive development than shunted children without myelomeningocele. Finally, the number of long-term survivors (2 patients) with untreated hydrocephalus is too small for commentary on the history of children with in-utero diagnosis of hydrocephalus.

The findings suggest that, of patients with in-utero diagnosis of hydrocephalus, less than half survive for long-term (4 year average) follow-up and 42% of shunted survivors have normal cognitive development. This community-acquired series, not collected from a high risk Obstetrical/Pediatrics Service, may reflect the more general experience of the neurosurgeon in caring of these patients.

3. SURGICAL TREATMENT AND LONG-TERM NEURODEVELOPMENTAL OUTCOME IN IDIOPATHIC AQUEDUCTAL STENOSIS (IAS)

Aimen Shaaban, BS, William C. Hanigan, MD, PhD
(Peoria, IL)

From 1983 to 1988, 15 infants were diagnosed with IAS using magnetic resonance imaging. This report will describe their surgical treatment and long-term neurodevelopmental outcome.

Group A (10 patients) presented with macrocephaly in utero or at birth and followed for a mean of 31 months. Group B presented with macrocephaly and.or developmental delay before 18 months of age and followed for a mean of 68 months. Low-pressure ventriculoperitoneal shunts were placed in all patients. Changes in frontal cortical mantle width (FCMW) were correlated with developmental changes in motor, language and cognitive/psychosocial scales. A developmental quotient of > 90% was graded as normal; a developmental quotient of < 70% was graded as severe delay.

Fourteen shunt revisions were performed in 9 children with one infection. Two patients developed subdural hematomas which did not require treatment; three patients developed seizure disorders. Mean preoperative FCMW was 16.6 mm for Group A and 25.3 mm for Group B. Postoperatively, 9 children (7-Group A) increased their FCMW over 5 mm.

Two children in Group A demonstrated normal development. No child demonstrated normal development on two scales; 4 children showed severe delays in one or

3. SURGICAL TREATMENT AND LONG-TERM NEURODEVELOPMENTAL OUTCOME IN IDIOPATHIC AQUEDUCTAL STENOSIS (IAS) (continued)

more scales. In Group B, 3 children were normal in two scales; two children showed severe delays in one or more scales. Postoperatively, no child with a FCMW of < 30 mm achieved a normal outcome on any scale; if the FCMW reached 30 mm, severe developmental delay did not occur. Increased FCMW was associated with improvement in language skills.

In summary, the surgical treatment of IAS in 15 infants was not associated with mortality or notable morbidity. The neurodevelopmental prognosis was poor. Two children (13.2%) demonstrated normal development, while 6 children (40%) showed severe delays. A FCMW of 30 mm was needed for normal neurodevelopment; increased in the FCMW following surgery was associated with improvement in language function.

4. SIMPLE, EARLY SYNOSTOSIS OPERATIONS

John Shillito, MD (Boston, MA)

This is a plea for the early correction of craniosynostosis by well-known simple techniques. Linear craniectomies carried out between two and six weeks of age do not immediately correct the deformity, but permit subsequent growth of the brain to do so. Adequate correction not only of cranial deformities can be achieved, but also many of the lesser secondary irregularities of the orbits and upper face.

The complex craniofacial procedures being recommended for single suture closure are unnecessary if early action is taken. Furthermore, many of these techniques restrict subsequent normal skull growth. Indications, risks, techniques and results will be shown.

5. MANAGEMENT OF CORONAL CRANIOSYNOSTOSIS IN EARLY INFANCY

S. Terence Myles, MD, MSc, FRCS (Alberta, Canada)

A number of different operative techniques have been described to treat coronal craniosynostosis, whether unilateral or bilateral. The results of advancement techniques, to bring the orbital margins and forehead forward, have been difficult to evaluate because of inclusion of infants under 6 months of age and older infants and children in many series. The influence of brain growth on the eventual outcome has therefore been variable.

This study compares the results of surgical treatment, utilizing 3 different advancement techniques, with a technique I have termed "forehead release". Twenty two (22) infants under 6 months of age were treated surgically, 11 by advancement and 11 by "release". The median age at surgery was 2.5 months in the advancement group, and 3 months in the "release" group. The advancement group included 5 infants with right coronal synostosis, 1 with left coronal synostosis, 4 with syndromic bilateral coronal synostosis, and 1 with left coronal and metopic synostosis. The "release" group included 4 infants with right coronal synostosis, 1 left coronal synostosis, 2 bilateral coronal synostosis, and 4 syndromic bilateral synostosis.

The diagnosis was made on clinical grounds and confirmed by appropriate radiological studies.

The surgical techniques will be described.

The initial cosmetic results were excellent in both groups. Two years after surgery, the cosmetic result was less satisfactory in the advancement group, with 5 children judged good results, 5 fair and 1 infant had died. In the "release" group, 5 remain excellent, 5 were good and 1 infant had died. Turricephaly was more marked in the advancement group, and 3 children in that group required repeat cranioplasty, while no reoperations have been done in the "release" group.

Forehead advancement was a longer operation, with average operating time 258 minutes versus 208 minutes for "release". Blood loss averaged 198 mls in advancement group, and 100 mls in the "release' group. Postoperative complications were more significant in the infants treated by advancement.

This study demonstrates that "forehead release" is the procedure of choice for infants less than 6 months of age, with coronal craniosynostosis, whether unilateral or bilateral.

6. TRIGONOCEPHALY: SURGICAL CONSIDERATIONS AND LONG-TERM EVALUATION

Steven J. Schneider, MD, Burt M. Greenberg, MD, Alan D. Rosenthal, MD, Alvin H. Harris, MD (New Hyde Park, NY)

Trigonocephaly results in a triangular shaped forehead with supraorbital and lateral orbital recession. Hypotelorism secondary to the metopic synostosis is often seen. Although these abnormalities are less severe than other craniofacial deformities, specific surgical correction is required in order to improve skull and upper face contour. This report carefully assesses long-term results and reviews important technical considerations.

Seventeen consecutive patients with metopic synostosis (1973-1990) were clinically and photographically analyzed with an average follow-up of 7 years, (Range 1-1/2-15-1/2 yrs). Three patients were female and 14 were male. The average age of surgical correction was 12.2 weeks (range: 1 week - 5 months). The coronal sagittal, and lamdoidal sutures were found to be unaffected at initial presentations. 3-D CT images are obtained in representative patients to illustrate the restored cranial bony anatomy.

Centrally, exposure is achieved subperiosteally to permit complete osteotomy of the fused metopic suture to the nasofrontal suture. Generally, the orbital osteotomy extends inferiorly to allow lateral orbital advancement as well. The sphenoid is partially resected to enhance orbital advancement. A "V-shaped" full thickness cranial bone

6. TRIGONOCEPHALY: SURGICAL CONSIDERATIONS AND LONG-TERM EVALUATION (continued)

graft is placed centrally to laterally displace the orbits. Frontal bone cranioplasty anterior to the coronal suture and squamous suture release are performed. Perioperative Decadron (2 mg), intravenous antibiotics and a spinal drainage catheter are used in all patients.

In our series, aesthetic restoration of contour was achieved in all patients. No patient required revisional surgery for turricephaly or recurrent orbital deformity. Average operative time equaled 3.2 hours (range 2-5 hrs). Average hospitalization was 6 days (range 4-13 days). No infectious complications or negative neurologic sequelae have been observed. Residual hypotelorism has not been found in these non-syndromic patient and representative inter-orbital measurements are presented. Patients to be presented illustrate typical long-term results. 3-D CT imaging will demonstrate original and restored bony anatomy.

7. SURGICAL MANAGEMENT OF SYNDROMIC VERSUS NON-SYNDROMIC BILATERAL CORONAL CRANIOSYNOSTOSIS

Paul C. Francel, MD, PhD, John A. Persing, MD, John A. Jane, MD, PhD (Charlottesville, VA)

In both syndromic and non-syndromic bilateral coronal craniosynostosis, A turribrachycephalic skull shape abnormality exists. However, in the syndromic group, the altered shape abnormalities are exaggerated in degree. In particular, these patients show marked hypoplasia of the anterior cranial base, the supraorbital rim, and the mid-face. We have found that surgical treatments to reshape the skull that have previously been shown to be successful in non-syndromic bilateral coronal synostosis are less effective if used unmodified in the syndromic patients. Individualization of the technique applied to the syndromic patients is necessary to maximize operative results. Technique is modified according to age: 3 age ranges are described; the patient less than one year of age, 1 to 3 years of age, and greater than 3 years of age. For patients less than one year of age, bone remodeling techniques, best suited to their pliable bone, and loose fixation of bone segments to allow for further brain growth are used. In patient who are older than 3 years of age, mature bone remodeling techniques and rigid fixation are employed. In children between 1 and 3, a combination of these principles is applied.

In this presentation, we will present the preoperative assessment required for these patients, and the specific operative details of bone remodeling and bone

7. SURGICAL MANAGEMENT OF SYNDROMIC VERSUS NON-SYNDROMIC BILATERAL CORONAL CRANIOSYNOSTOSIS (continued)

fixation that we use for each subclass of patients based on age and degree of hypoplasia of the anterior cranial base, supraorbital rim, and mid-face. We then relate the treatment principles to the pathophysiologic principles that we believe underlie these skull shape abnormalities.

Finally, clinical cases are presented that compare our surgical results in these patients with the pre-operative baseline skull shape abnormality and the idealized skull shape.

8. INTRA-OPERATIVE ICP MONITORING IN CRANIOSYNOSTOSIS: A PRELIMINARY REPORT

Louis W. Solomon, MD, Ernesto Ruas, MD (St. Petersburg, FL)

Neurosurgeons treating craniosynostosis are concerned about the associated craniofacial deformities, as well as the possible consequences of cerebral compression. Classical teaching has implied that premature closure of a single cranial suture results in only "cosmetic deformities". With the fusion of two or more sutures the possibilities of increased intracranial pressure may become a factor. This preliminary study involves intra-operative monitoring of intracranial pressure utilizing a Camino fiber-optic system. The monitor is placed after the induction of general anesthesia and on the involved side. The ICP is recorded before and after the craniotomy, without hyperventilation.

ICP measurements before and after craniotomies have been recorded in patient with sagittal, unilateral coronal, bicoronal, and metopic craniosynostosis. In patients with unilateral coronal synostosis the ICP measurement was recorded on the side of the fusion. In bicoronal synostosis the measurement was made in the right frontal region.

In bicoronal synostosis pre-craniotomy ICPs ranged from 28-31, post-craniotomy ICPs ranged from 4-14. In unilateral coronal synostosis, pre-craniotomy ICPs ranged from 11-20 with post-craniotomy, values 2-7. In sagittal craniosynostosis pre-craniotomy ICP was 26 and post-craniotomy ICP was 9. In metopic synostosis pre-craniotomy ICP was 22, post-craniotomy ICP was 4. There were no complications from ICP monitoring.

8. INTRA-OPERATIVE ICP MONITORING IN CRANIOSYNOSTOSIS: A PRELIMINARY REPORT (continued)

This preliminary study suggests that even in single suture forms of craniosynostosis focal elevated ICP may be a factor. Hopefully other craniofacial teams will consider collecting ICP data on craniofacial patients.

9. DEVELOPMENT OF THE HARLEQUIN DEFORMITY IN UNILATERAL CORONAL SYNOSTOSIS

Johnny B. Delashaw, Jr, MD, J.A. Persing, MD, C. Luce, MD, J.A. Jane, MD, PhD (Gainesville, FL)

Premature fusion of a coronal suture clinically produces several characteristic deformities: at the cranial vault there is flattening of the ipsilateral frontal and parietal region, and prominence of the ipsilateral temporal and contralateral frontal bones; the Harlequin deformity is produced at the cranial base by ipsilateral elevation of the orbital roof and sphenoid wing; at the facial skeleton there is prominence of the ipsilateral zygoma. Recently, a hypotheses for skull growth that predicts the cranial vault deformities observed in single suture synostosis was described (Delashaw et al., J. Neurosurg 70:159-165, 1989). This hypothesis predicted that premature fusion of the coronal suture produces a fronto-parietal bone plate with reduced growth potential. To compensate for this restricted bone plate, bone is assymetrically deposited along adjacent cranial vault bones. By expanding this preciously described hypothesis to the basal sutures, the observed cranial base and facial deformities in unilateral coronal synostosis can also be predicted. Specifically, increased bone deposition directed away from the restricted fronto-parietal bone plate occurs at the adjacent frontosphenoid and frontozygomatic sutures. The Harlequin deformity is produced by sphenoid wing being artificially elevated due to the increased compensatory growth of the sphenoid bone and to the lack of growth of

9. DEVELOPMENT OF THE HARLEQUIN DEFORMITY IN UNILATERAL CORONAL SYNOSTOSIS (continued)

the fronto-parietal bone plate. Assymetric bone deposition at the frontozygomatic suture away from the frontal bone produces the characteristic prominence of the ipsilateral zygoma. Experimental evidence and clinical examples will be presented to support this compensatory growth hypothesis which predicts the observed Harlequin deformity and facial skeleton abnormality seen in unilateral coronal synostosis.

10. HISTOCHEMICAL ANALYSIS OF CALVARIAL SUTURES: NEW INSIGHTS ON SKULL GROWTH AND THE ETIOLOGY OF CRANIOSYNOSTOSiS

Michael J. Burke, DVM, MS, MD, Ken R. Winston, MD
(Denver, CO)

Craniosynostosis is a disorder wherein a calvarial suture fuses prematurely resulting in an abnormally shaped head. These children are normal neurologically and the bone bridging the suture is normal histologically. The mechanism of sutural fusion is unknown. These facts prompted the authors to re-examine normal sutural anatomy and the concepts of skull growth in an animal model.

Histochemical staining, to identify osteoblasts and osteoclasts, and tetracycline labeling were performed on neonatal rabbit calvarial sutures. Osteoblasts are found on all bony surfaces including the sutural edges but do not extend across the sutural space. Thus, "periosteum", per se, does not bridge the suture. Osteoclasts are found only in the diploic space. Thus, there is no mechanism to remove bone at or with the suture, contrary to current thoughts on skull growth. Tetracycline labeling revealed immense bone production at the suture, as compared to dural and periosteal surfaces. Microscopic spicules of bone bridged the suture in several sections.

Based on the above observations, we propose a new hypothesis for the etiology of craniosynostosis. Bony microspicules normally and intermittently form and bridge the suture. As there is no cellular mechanism to remove

these spicules, we propose that normal mechanical forces cause them to fracture. A spicule that fails to fracture functions as a scaffold, upon which more bone is deposited, resulting in clinical craniosynostosis. Craniosynostosis therefore is a persistence and exaggeration of a normal anatomic process.

11. ORGANIZATION OF CRANIOCAUDAL NEURAXIAL LEVELS DURING INDUCTION OF THE CENTRAL NERVOUS SYSTEM IN AN EXPERIMENTAL MODEL

Mark S. Dias, MD, Gary C. Schoenwolf, PhD, Marion L. Walker, MD, FAAP (Salt Lake City, UT)

Inductions of neurepithelium from undifferentiated embryonic ectoderm is the first and one of the most important events in the development of the nervous system. In avian embryos, previous studies have shown that transplantation of Hensen's node to an indifferent region (the germinal crescent) of a host embryo results in the formation of a secondary embryo containing ectopic neurepithelium. These studies have suggested that the craniocaudal level of the induced neuraxis is determined by the age of the donor: young donors induce cranial neuroaxial levels, whereas old donors induce caudal levels. However, these studies all lack a cell marker to reliably determine whether ectopic neurepithelium is induced (derived from the host) or self-differentiated (derived from the donor). We have overcome this problem by transplanting quail Hensen's nodes to the germinal crescent of chick blastoderms and using a quail nucleolar heterochromatin marker to identify graft cells in ectopic embryos. We systematically varied both donor and host ages to examine the effects of graft and host age on induction and self-differentiation of ectopic neurepithelium.

Our results demonstrate that the frequency of host induction decreases, whereas the frequency of graft self-differentiation increases, with advancing donor age.

11. ORGANIZATION OF CRANIOCAUDAL NEURAXIAL LEVELS DURING INDUCTION OF THE CENTRAL NERVOUS SYSTEM IN AN EXPERIMENTAL MODEL (continued)

In addition, although induction of more caudal levels did not occur with advancing graft age, self-differentiation of more caudal levels did occur, and suggests that the caudal "induction" seen in previous studies was more likely caudal self-differentiation. We conclude that the role of neural induction is to produce neurepithelium of unspecified regional character, and that the formation of craniocaudal subdivision of the neuraxis depends upon subsequent morphogenetic events. Finally, we found a direct correlation between the frequency of neural induction and the quantity of graft-derived endodermal cells in ectopic embryos, supporting a previous assertion (Gallera and Nicolet, 1969) that, at least in avian embryos, the earliest and principal source of neural inducer lies in the endoderm rather than the mesoderm.

12. CRYOMICROSECTION OF A TWENTY WEEK GESTATION FETUS WITH MYELOMENINGOCELE

John R. Ruge, MD, David M. McLone, MD, PhD (Park Ridge, IL)

A 20 week gestation fetus with myelomeningocele was studied using plain roentgenography, MRI, and Cryomicrosection. Cryomicrosection was performed after suspending the fetus in methylcellulose at negative 70 degrees centigrade. Ten micron sections were performed along the parasagittal axis to the midline and then axial sections were taken of the remainder of the cranium. Photographs of each section were analyzed and compared with MRI and plain roentgenograms. Basiocciput concavity, sphenoid scalping with foreshortened internal auditory canals and a large foramen magnum are present while most of the cranial base is still cartilagenous. A small posterior fossa with typical Chiari II findings are present. The "unified" theory of the development of the Chiari malformation is discussed in light of these findings.

13. THE CAUSE OF CHIARI II MALFORMATION

David G. McLone, MD, PhD, Shigehiro Nakahara, MD, Paul A. Knepper, MD, PhD (Chicago, IL)

The cause of the Chiari II hindbrain deformity in children born with a myelomeningocele can be explained by the lack of distension of the embryonic ventricular system. Defective occlusion and an open neural tube precludes the accumulation of fluid and pressure within the cranial vesicles. This distention is critical to normal brain development. The small posterior fossa, cerebral disorganization, and luckenschadel are the result.

There are a series of time-linked events in the pathogenesis of the Chiari II malformation, and these time-linked events correlate with the severity of the Chiari malformation. Our theory identifies the developmental sequence and consequences of five developmental events: (1) Abnormal neurulation is an a priori feature of Chiari II malformation. (2) Failure of correct timing of occlusion of the spinal neuroceles or of leakage of CSF leads (3) to failure to maintain distention of the primitive ventricular system which (4) alters the inductive effect of pressure on the surrounding mesenchyme and endochondral bone formation and results in a small posterior fossa. Finally, (5) hydrocephalus is secondary to maldevelopment on the cerebrospinal outflow pathway.

14. EFFECTS OF EXPERIMENTAL INFANTILE HYDROCEPHALUS AND VP SHUNTS ON MOTOR CORTEX CONNECTIONS

James. P. McAllister, PhD, John S. Way, PhD, Steven D. Katz, BS (Philadelphia, PA)

Since previous neurotransmitter studies suggest that cortical afferents are altered irreversibly by ventriculomegaly, an axonal tracer study was iniated to map motor cortex connections directly. Hydrocephalus was induced in 10-11 day old kittens by intracisternal injection of 25% kaolin and monitored by ultrasound; some hydrocephalic animals received VP shunts at 11-12 days post-kaolin; normal age-matched animals served as controls. Lectin-bound horseradish peroxidase injections were made unilaterally in cortical areas 4, 6 and 3 to: hydrocephalic animals at 9-15 days post-kaolin; shunted animals at 1, 2 & 4 weeks post-shunt; age-matched control animals. Sections were processed by TMB histochemistry and analyzed light microscopically. In hydrocephalic brains, retrograde labeling of neuronal cell bodies (indicating cortical afferents) was absent in the contralateral cortex, reduced considerable in the ipsilateral claustrum, nucleus basalis, relay and intralaminar thalamic nuclei, dorsal raphe, ventral tegmental area and midbrain reticular formation, but normal in the locus coeruleus. Axonal labelling (indicating cortical efferents) was reduced in the ipsilateral thalamus, internal capsule, crus cerebri, pons, dorsal column nuclei and pyramids. Post-shunt ventriculomegaly was much reduced and accompanied by marked neurological improvements. All shunted animals exhibited retrograde labelling similar to controls, but axonal labelling was mildly reduced. These results indicate structural damage and/or impairment of axonal transport

14. EFFECTS OF EXPERIMENTAL INFANTILE HYDROCEPHALUS AND VP SHUNTS ON MOTOR CORTEX CONNECTIONS (continued)

occurs in all cortical pathways during hydrocephalus. Decompression appears to allow restoration of only the afferent connections, with incomplete recovery of cortical efferents. These results will be discussed in relation to our quantitative analyses of neuron size and density.

Supported by HD21527 to JPM.

15. EFFECTS OF EXPERIMENTAL INFANTILE HYDROCEPHALUS AND VP SHUNTS ON CEREBRAL BLOOD FLOW AND SOMATOSENSORY EVOKED POTENTIALS

Usha S. Vasthare, PhD, James P. McAllister, PhD, Ronald F. Tuma, PhD, Robert H. Rosenwasser, MD, Pamela M. Hale, BS (Philadelphia, PA)

Our previous preliminary studies have suggested that reductions of cerebral blood flow (CBF) in an animal model of infantile hydrocephalus are similar to those observed clinically. The present report expands these findings to permit statistical evaluations and include measurements of somatosensory evoked potentials (SSEP). Hydrocephalus was induced in 4-10 day old kittens by intracisternal injections of 25% kaolin and verified with ultrasound; saline-injected or normal animals served as age-matched controls (n=5). The isotope labelled microsphere method was used to measure CBF in severely hydrocephalic animals (n=5) at 15-20 days post-kaolin. Standard SSEP measurements were performed on control and hydrocephalic animals, as well as a group of hydrocephalic animals that received VP shunts at 6-13 days post-kaolin. Significant ($p<0.05$) decreased in CBF were detected in areas 4 (55% below controls), 22 (56%) and 17 (58%), as well as the thalamus (46%), midbrain and pons (55%), cerebellum (50%) and caudate nucleus (61%). A Cushing response was evidenced by decreases in heart rate (22%) and cardiac output (70%), and a 221% increase in total peripheral resistance. The mean CBF never fell below 20 ml/min/100g in any area. Nevertheless, the chronic nature of the CBF reduction and its occurrence in immature brains supports the possibility that ischemia exists during hydrocephalus. In addition, statistically significant

15. EFFECTS OF EXPERIMENTAL INFANTILE HYDROCEPHALUS AND VP SHUNTS ON CEREBRAL BLOOD FLOW AND SOMATOSENSORY EVOKED POTENTIALS
(continued)

increases in the latency of the SSEP cortical peak, as well as decreases in its amplitude, were found during hydrocephalus. In general. these SSEP alterations were reversed by shunting. The time course of the SSEP improvement, as well as our preliminary data on laser Doppler measurements of local CBF after shunting, will be discussed. Supported by HD21527 to JPM.

16. HIGH ENERGY PHOSPHATE METABOLISM IN NEONATAL HYDROCEPHALUS

J.M. Drake, MD, M. da Silva, MD, A. Mock, MD, S.D. Michowiz, MD, U.I. Tuor, MD (Toronto, Ontario)

The pathogenesis of the brain injury to hydrocephalus remains poorly understood, particularly in the developing brain. A few reports have documented changes in high energy phosphate metabolism (HEPM) in animal models of hydrocephalus. MR in vivo spectroscopy is a non-invasive technique for measuring HEPM.

Hydrocephalus was produced in 1 week old kittens by injection of Kaolin into the cisterna magna. This resulted in rapid ventricular enlargement, splitting of the sutures, sun setting of the eyes, progressive spastic paraparesis, loss of appetite and lethargy. HEPM was measured 1 week following kaolin injection in 9 control and 9 hydrocephalic litter mates. The animals were placed in a 2 Tesla MR unit. Ventricular size and surface coil placement was documented with MR images. P31 spectra were obtained using a 4 cm surface coil from a region including the dorsal aspect of both hemispheres. One thousand free induction decays were averaged and peak areas calculated following deconvolution of the spectra.

The p31 spectra of neonatal cats differed from reported spectra of adult cats with a lower phosphocreatine (PCR) peak. There was a very small decrease in the cerebral PH in the hydrocephalic animals (.02). There was no significant difference in PCR/PI or PCR/ATP ration in the hydrocephalic animals. Neonatal cats appear to undergo a maturation of the HEPM system analogous to that in humans. The preservation of HEPM in the hydrocephalic animals may be related to the stage of the hydrocephalus, or a difference in the response of the neonatal brain to the ventricular enlargement.

17. REGIONAL DISTRIBUTION OF CEREBRAL BLOOD FLOW IN NEONATAL HYDROCEPHALUS

S.D. Michowiz, MD, A. Mock, MD, U.I. Tuor, MD, J.M. Drake, MD (Toronto, Ontario)

Ventricular enlargement and an increase in intracranial pressure are considered to be some of the factors that cause brain damage in hydrocephalus. A reduction in cerebral blood flow (CBF) may also be important, yet little is known of the changes in CBF in the developing brain affected by hydrocephalus.

Injection of 25% kaolin into the cisterna magna in one-week-old kittens produced neonatal hydrocephalus. An increased intracranial pressure with rapid ventricular enlargement occurred in all the animals associated with splitting of the sutures, sunsetting eyes, progressive spastic paraparesis, loss of appetite and lethargy.

Using this model, control and hydrocephalic kittens were evaluated by ultrasound and magnetic resonance imaging at 1 week post kaolin injection (2 weeks of age). Local CBF was measured by c14 iodoantipyrine autoradiographic technique. The animals were ventilated and the physiological parameters, temperature, mean arterial blood pressure and blood gases were stabilized. In the hydrocephalic animals statistically significant reductions of cerebral blood flow were distributed regionally; frontal cortex 65.3% periaqueductal area 57.2%, $p<0.05$, lateral thalamus 51.5%, $p<0.005$ (expressed as percentage of control). The maximal decrease was found in the periventricular white matter (37.5% of control, $p<0.005$). Hypoperfusion also occurred

17. REGIONAL DISTRIBUTION OF CEREBRAL BLOOD FLOW IN NEONATAL HYDROCEPHALUS (continued)

in areas remote from the ventricles such as the cerebellar cortex (60.4% of control, $p<0.005$). Loss of body weight in hydrocephalic animals did not correlate with changes in CBF. These regional CBF changes in hydrocephalus may partially explain the pathogenesis of this disorder.

18. EFFECTS OF 8-(p-SULFOPHENYL) THEOPHYLLINE ON PIAL ARTERIOLAR DIAMETER DURING HYPOTENSION IN PIGLETS

T.S. Park, MD, Jeffrey M. Gidday, PhD, Ernesto Gonzales, MD (St. Louis, MO)

In piglets, brain interstitial adenosine concentrations increase during hypotension, indicating the possible role of adenosine in the regulation of neonatal cerebral blood flow under the condition of hypotension. To further examine the issue, we investigated whether an adenosine receptor blocker, 8-(p-sulfophenyl) theophylline (8-SPT), attenuates the pial arteriolar dilation in response to graded hypotension.

A cranial window was placed in isoflurane-anesthetized piglets (<5 d old) and pial arterioles of 50-100 um in diameter were examined with a videocamera. Blood pressure was then lowered stepwise in decrements of 10 mmHg by hemorrhage and the vessel diameters were measured at each level of blood pressure.

In the control group (n=10), the cranial window space was superfused with artificial CSF throughout the experiment. Graded hypotension caused a progressive dilation of pial arterioles: percent increases at blood pressures of 50, 40 and 30 mmHg were 20±7, 40±7, and 48±8, respectively ($p<0.001$ vs control). In the experimental group (n=9), artificial CSF containing 10-6M 8-SPT was infused into the lateral ventricle at a rate of 200 ul/min for 50 min and allowed to exit via a port in the cranial window. Following the infusion, the cranial window space was superfused directly with the same CSF containing 8-SPT at a rate of 50 ul/min for 10 min. Intracranial pressure under the

18. EFFECTS OF 8-(p-SULFOPHENYL) THEOPHYLLINE ON PIAL ARTERIOLAR DIAMETER DURING HYPOTENSION IN PIGLETS (continued)

window remained at <2 mmHg throughout the infusions. Blood pressure was then lowered in the same stepwise fashion. In this group, percent increases in the arteriolar diameter at blood pressures of 50, 40 and 30 mmHg were 0±4, 11±6 and 17±7, respectively ($p>0.05$).

These results support a role for adenosine in the regulation of neonatal cerebral blood flow during hypotension.

Supported by NIH grant R01 NS21045

19. BASILAR PONS ATTRACTS IT CORTICAL INNERVATION BY CHEMOTROPIC INDUCTION OF COLLATERAL BRANCH FORMATION

Christopher D. Heffner, MD, Dennis D.M. O'Leary, PhD, (Sponsored by T.S. Park, MD) (St. Louis, MO)

The mammalian corticopontine projection, which arises from layer 5 of neocortex, develops by delayed interstitial budding of collaterals from corticospinal axons, rather than by direct ingrowth of primary axons or by bifurcation of the axon growth cone. Branches form in the axon tract, directly overlying the basilar pons. Here we present in vitro evidence that basilar pons stimulates cortical axon branch formation and directed growth of cortical axons and collaterals from layer 5 neurons.

First, explants of rat neocortex were co-cultured with appropriately aged explants of basilar pons in 3-D colagen matrices. Cortical axons were shown to grow preferentially toward basilar pontine tissue as compared with control tissues. Axons contacting the basilar pontine explant were shown, by fluorescent dil labeling, to be both primary axons and collateral branches.

Next, explants of cortex were grown alone, allowing axons to extend into the collagen gel. 24 hours later, explants of basilar pons were explanted into the gel along side of the cortical axons. Branches were seen to form on cortical axons after placement of pons, but not after placement of control tissue. 86% of axons contacting the basilar pontine explants were seen by dil labeling to arise from layer 5 cortical neurons.

We conclude that basilar pons releases a diffusible tropic signal that acts preferentially on layer 5 cortical neurons to direct axon growth, and also induces the formation of axon collateral branches, within both a neural and collagenous substrate.

20. ELEVATED CORTICAL VENOUS PRESSURE IN HYDROCEPHALUS

H.D. Portnoy, MD, M.E. Castro, MD, J. Maesaka, MD (Bloomfield Hills, MI)

In order to gain a better understanding of cerebrospinal fluid (CSF) hydrodynamics and the relationship to the cerebrovascular system, normal and naturally hydrocephalic dogs were studied to determine transmantle (TMP; lateral ventricle, LV, to subarachnoid space, SAS), and transparenchymal (TPP; LV to cortical vein, CV) pressures. Pressure was also measured in the sagittal sinus (SS), cisterna magna and femoral artery. CV pressure has not previously been measured in hydrocephalus. Ventricular volume was determined by computed tomography. Four group of animals were studied. Group 1 (n=5) measured TMP and group 2 (n=5), TPP in normal animals. Group 3 (n=5) measured all the pressures in normal animals and group 4 (n=6) measured the pressures in hydrocephalic animals. Pressure Volume Index (PVI) and CSF outflow resistance (Rout) were also measured. LV volume in the normal dogs was 1.3 ± 0.7ml and in the hydrocephalic dogs, 5.1±2.7 ml ($p<0.005$). Though LV, SAS and SS pressures were elevated in the hydrocephalic dogs (15.1 vs 10.2; 16.4 vs 10.5; 8.4 vs 5.2 mm Hg, respectively), the TMP and SAS to SS gradients were not significantly altered. CV pressure was markedly elevated in the Hydrocephalic animals (21.5 vs 11.7 mm Hg, $p<0.005$). PVI and Rout were not significantly different. These results suggest that an elevated CV pressure plays a role in the development and/or maintenance of hydrocephalus; and that the pathway for CSF absorption includes transcapillary or transvenular absorption of CSF from the interstitial space.

21. HYDROCEPHALUS AND THE CHIARI I MALFORMATION IN PATIENTS WITH CROUZON'S AND APERT'S SYNDROME

Paul W. Francis, MD, Stephen Beals, MD, Harold L. Rekate, MD, Jacque Reiff, RN, Hal W. Pittman, MD, Kim H. Manwaring, MD (Phoenix, AZ)

Frequently patients born with craniofacial syndromes, such as Crouzon's and Apert's syndrome, will develop hydrocephalus following initial craniofacial reconstruction procedures. While the pathophysiology of hydrocephalus in these conditions has not been completely elucidated, recent evidence suggests that stenosis of the jugular foramen with increased venous resistance may play a major role.

Once the hydrocephalus is treated, the venous hypertension would remain, potentially leading to increased brain turgor. Over time with a fixed calvarium, this increased brain turgor could lead to cerebellar tonsillar herniation (Chiari I malformation).

We have studied six children with these syndromes (five with Crouzon's and one with Apert's). Five of the six have shown severe tonsillar herniation on MRI. One of these patients exhibited signs of pseudotumor cerebri and one has a spastic quadriparesis. While developmental delays and motor dysfunction are found in these children, no specific cause has been delineated.

We contend that venous outflow obstruction is the cause of the hydrocephalus in these children. Shunting does not reverse the venous occlusive difficulties which may lead to high brain tissue pressures and tonsillar herniation. This cascade of events may relate to the motor and developmental problems seen in these children.

22. ATROPHY VERSUS HYDROCEPHALUS IN HURLER'S SYNDROME

Mitesh V. Shah, MD, Stephen J. Haines, MD, Chester B. Whitley, MD, Kumar Belani, MBBS, William Krivit, MD (Minneapolis, MN)

Ventriculomegaly in Hurler syndrome has been typically ascribed to atrophy. Hydrocephalus, however, can be an important unrecognized contributing factor. Currently there is no data regarding the frequency of hydrocephalus.

We retrospectively analyzed the clinical radiographic and CSF pressure findings of 18 Hurler patient (6 males) from 1980 - 89. Sixteen patients were undergoing pre-bone marrow transplant evaluation. Evans Index (EI) (maximum width of frontal horn/maximum width from inner tables) was calculated from pre-op CT scans. Lumbar CSF pressure measurements were obtained with patients under anesthesia.

Five patients (28%) underwent V-P shunting at average age of 42 months (10-153). Simultaneous progression of head circumference (HC) and ventriculomegaly that correlated with an elevated lumbar CSF pressure was seen in 4 of 5 patients. The remaining patient had symptoms of increased ICP with progression of ventriculomegaly and elevated ventricular pressure. All 5 shunted patient and 7/10 non-shunted patients had HC 2 standard deviations above the mean. The mean EI for the shunted group was 0.53 (0.41-0.62) and 0.26 (0.11-0.36) for non-shunted group. The mean lumbar CSF pressure prior to shunting was 36 cm H20 (26-52). One patient initially had low lumbar pressure but subsequently this increased. Mean lumbar pressures in the non-shunted group was 22 cm H20.

22. ATROPHY VERSUS HYDROCEPHALUS IN HURLER'S SYNDROME (continued)

Ventriculomegaly in Hurler syndrome can be due to a combination of atrophy and hydrocephalus. Measurements of CSF pressure aids in determining relative contribution of each. Progression of ventriculomegaly and HC correlates with elevated lumbar CSF pressure.

23. VENTRICULOPLEURAL SHUNTING: USE AS A TEMPORARY DIVERSION

Crystal D. Willison, MD, Howard H. Kaufman, MD, Thomas A. Kopitnik, MD, Robert Gustafson, MD, Eric Jones, MD, PhD (Morgantown, WV)

Although ventriculopleural shunts may be used for the permanent treatment of hydrocephalus in the older child (age > 8), this is not so in the very young patient. Due to the limited absorptive capacity of the pleural cavity with the subsequent development of symptomatic effusions, infants and young children are not generally candidates for pleural shunts. We report the use of temporary shunting into alternate sides of the chest cavity before inserting a ventriculoatrial shunt in a young patient in whom a ventriculoperitoneal shunt was not tolerated. Pleural effusions were removed by thoracentesis when necessary, and the shunt catheter was changed to the opposite side of the chest when effusions reaccumulated within one week. Utilizing the ventriculopleural shunts allowed one to avoid a final revision on the ventriculoatrial shunt while allowing one year of vertical growth and therefore minimized the need for frequent future lengthening revisions. This strategy permitted us to wait for one year prior to final revision back to a ventriculoatrial shunt.

24. EFFECT OF SUBCUTANEOUS IMPLANTATION ON ANTI-SIPHON DEVICE FUNCTION

Marcia C. da Silva, MD, James M. Drake, MD (Toronto, Ontario)

Anti-siphon devices (ASD) are added to CSF shunts to prevent the complications of over drainage. Their proper function relies upon the movement of a flexible membrane in response to external atmospheric pressure. Implantation produces a fibrous capsule common to all silastic devices. Increased pressure within the capsule, or loss of membrane mobility could interfere with ASD function.

ASDs were initially bench tested at flow rates between 10 - 50 cc/hr and with the distal catheter height between 0 to -60 cm. There was a small increase in pressure with increased flow rate in the horizontal position ($p<.001$). The inflow pressure initially dropped with the distal catheter height at -20cm; it then rose progressively with distal catheter heights of -40 and -60 cm ($p<.001$). To determine the effect of ambient pressure the devices were placed in a barometic chamber at pressures between -200 to +200 mm H20. Positive pressures caused a linear increase in inflow pressure; negative chamber pressure reduced the antisiphon effect.

Eight ASDs were implanted subcutaneously in piglets and tested in situ weekly for 4 weeks. Implantation caused a mean increase in inflow pressure 7 days after implantation of 93.5 mm H20 ($p<0.001$), which persisted for 4 weeks. Incision of the capsuled surrounding the ASD at the end of 4 weeks caused a drop in pressure. The capsule consisted of an outer layer of collagen fibres with an inner layer of histiocytes. Subcutaneous implantation of ASDs causes an increase in the ambient pressure of the device which significantly increases their resistance to flow.

25. COMPENSATION REVERSAL AFTER SHUNTING FOR HYDROCEPHALUS ("CRASH")

Patrick Roth, MD, Alan R. Cohen, MD (Boston, MA)

Patients who fail to respond appropriately to routine therapeutic endeavors can sometimes be a source of unique observations about the pathophysiology of disease. The authors report two patients with compensated hydrocephalus who deteriorated acutely following elective shunt revision. Preoperatively both patients had longstanding mild stable clinical deficits. Neither patient had a functioning shunt before surgery; in fact one patient had no shunt and the other had a documented shunt obstruction. In both cases a new proximal shunt malfunction developed in the immediate postoperative period. Therefore, surgical intervention in each instance involved simply the transient drainage of cerebrospinal fluid (CSF) from the ventricles up to the point at which the shunts failed. Both patients decompensated abruptly after operation. One developed a herniation syndrome over several hours and the other developed progressive intractable headache and orbitalgia. Deterioration was accompanied by increased ventricular size in both patients, and both improved after a functioning shunt was restored.

We hypothesize that the clinical deterioration observed following transient CSF drainage may be on the basis of elimination of pressure dependent accessory pathways, or possibly related to alterations in the viscoelastic properties of brain. The authors will call attention to the phenomenon as a potential source of clinical deterioration in patients with compensated hydrocephalus undergoing such benign procedures as lumbar puncture or diagnostic shunt tap.

26. ENLARGEMENT CRANIOPLASTY FOR TREATMENT OF SLIT-VENTRICLE SYNDROME. CASE REPORT. DISCUSSION OF PATHOPHYSIOLOGY AND TREATMENT OF SLIT VENTRICLE SYNDROME.

Gregory W. Hornig, MD, Ken Winston, MD (Kansas City, MO)

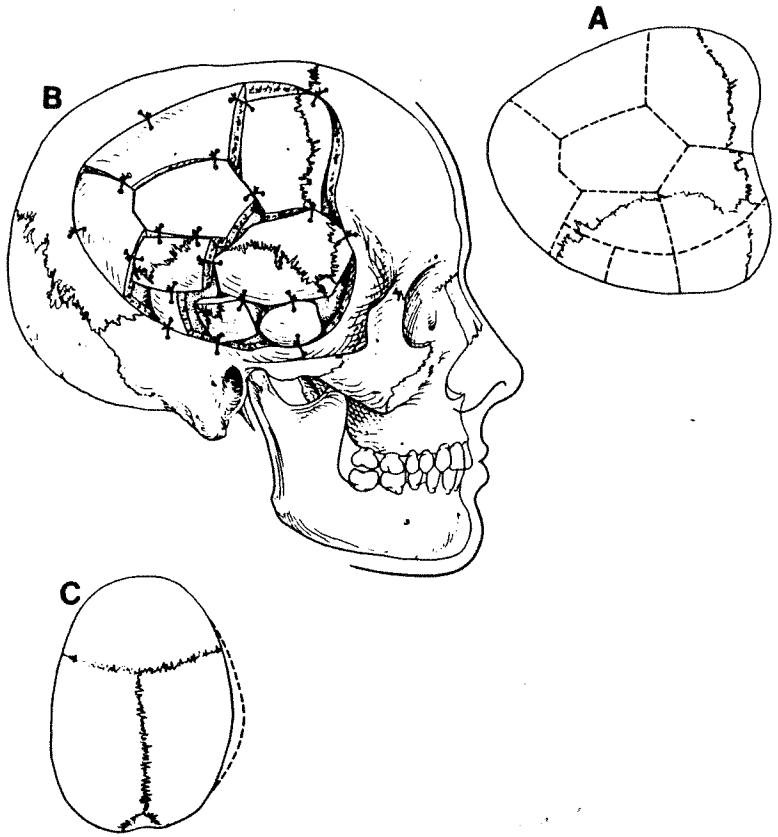
Summary

A fifteen-year-old girl with shunted hydrocephalus and Chiari I malformation developed severed headaches. CT scan demonstrated slit-like ventricles. She continued to be symptomatic despite multiple shunt revisions and upgrading of valve pressure. While on external ventricular drainage in hospital, she had recurrent episodes of loss of consciousness, opisthotonic posturing and severe bradycardia. Most of these episodes occurred when drainage was interrupted although one occurred during continued CSF drainage.

A large hemicranial craniotomy was made on this moribund patient. The bone flap was divided in nine pieces. The pieces were reassembled to permit outward bulging of the reconstructed hemicranium; the gain in intracranial volume was approximately 20-30 cubic mm (see diagram). Following enlargement cranioplasty the patient was normal. Her ventricles were slightly enlarged. A small wound dehiscence complicated her recovery.

In discussing this case we will review alternative methods of treatment of the slit-ventricle syndrome, many of which were not successful in this particular patient. A rational for this procedure--expansion cranioplasty--will be offered based on our understanding of the pathophysiology of the slit-ventricle syndrome.

26. ENLARGEMENT CRANIOPLASTY FOR TREATMENT OF SLIT-VENTRICLE SYNDROME. CASE REPORT. DISCUSSION OF PATHOPHYSIOLOGY AND TREATMENT OF SLIT VENTRICLE SYNDROME (continued)



27. MULTILOCULATED HYDROCEPHALUS: TREATMENT WITH CRANIOTOMY AND VENTRICULAR FENESTRATION

Todd Nida, MD, Stephen Haines, MD (Minneapolis, MN)

Multiloculated hydrocephalus is an acquired disorder most often attributed to intraventricular infection or hemorrhage. CT and MRI imaging have made diagnosis easier and the problem is more frequently encountered than in the past. Traditional treatment has consisted of shunting, often requiring placement of multiple systems and multiple revision. Out of frustration, we have attempted craniotomy and fenestration of intraventricular septations to create a single compartment, followed by single shunt placement. Six patients treated in this fashion from 1976 to present have been reviewed. The average follow-up period is 46 months. We have found that the post-fenestration requirement for shunt revision has markedly diminished. We compare our treated group to two sets of controls: patients with multiloculated hydrocephalus that were treated in a traditional manner and patients with hydrocephalus attributable to either neonatal ventriculitis or intraventricular hemorrhage that required a shunting procedure, but did not demonstrate evidence of multiloculation on CT imaging. Our preliminary experience with this procedure leads us to advocate it as primary treatment for children with multiloculated hydrocephalus.

28. ENDOSCOPIC FEATURES AND MANAGEMENT OF UNILATERAL OBSTRUCTIVE HYDROCEPHALUS–AVOIDING A SHUNT

Kim H. Manwaring, MD (Phoenix, AZ)

Six consecutive cases of unusual congenital unilateral obstructive hydrocephalus have been studied by ultrasound, iohexol contrast CT ventriculogram, and MRI. At surgery, endoscopic visualization of the abnormal area of the foramen of Monro was undertaken, revealing etiologies of apparent atresia, obstructive cysts arising from choroid plexus, filling with dense tufts of choroid, or stenosis. Septostomy or cyst excision was achieved in four cases; two have remained free of a shunt long term with radiographic and neurologic evidence of improvement. Wide fenestration of the septum pellucidum or cyst excision rather than simple puncture appears necessary to avoid repeat obstruction.

Endoscopic tools for septostomy and excision include a steerable fiberscope or 30 degree (side-looking) lens scope, radiofrequency tissue vaporizer, cold dissector, and needle aspirator. Non-conductive water as a focal irrigant appears promising for microscopic contact RF dissection. Computer-based digitized realtime imaging allows simultaneous comparison of unoperated and dissected tissues, clarifying confusing nearfield anatomy.

29. ENDOSCOPIC VENTRICULAR SURGERY

Alan R. Cohen, MD, Carl B. Heilman, MD (Boston, MA)

Although ventriculoscopic surgery was first performed in 1910, only recently has this technique begun to gain popularity among neurosurgeons. Advances in optics and illumination now make it possible to operate safely within the ventricular system with minimal invasiveness. The authors report their experience with ventricular endoscopy in 26 patients using a flexible, steerable fiberoptic ventriculoscope.

The ventriculoscope was used to fenestrate symptomatic loculated cerebrospinal fluid collections such as isolated intraventricular cysts, suprasellar arachnoid cysts, and trapped lateral ventricles secondary to foramen of Monro obstruction. Ventricular fenestration was carried out with a "saline torch" dissector introduced through a small working channel in the ventriculoscope. The torch was effective in coagulating vessels and sculpting large windows in the cyst walls and the septum pellucidum. Communication of cerebrospinal fluid between compartments was confirmed by postoperative CT-ventriculograms. The saline torch was also used to perform third ventriculocisternostomy in patients with non-communicating hydrocephalus, permitting creation of a window in the third ventricular flood just anterior to the mammillary bodies.

The flexible ventriculoscope has been helpful in treating multiple problems related to the cerebral ventricles. Saline torch dissection has been used to free shunt catheters stuck in the vascular choroid plexus. Snares introduced through the ventriculoscope's working channel have

29. ENDOSCOPIC VENTRICULAR SURGERY (continued

permitted retrieval of wandering shunt catheters both form the ventricles and the peritoneum. The ventriculoscope has also been used to biopsy deep tumors under direct vision.

Ventricular endoscopy has become an important adjunct in the management of hydrocephalus, permitting the simplifications of shunt systems in some patients and elimination of shunts in others. Deep tumors can be biopsied non-invasively under direct vision, and we believe ventriculoscopy will ultimately become the procedure of choice for aspiration and vaporization of many intraventricular tumors.

30. GRAM NEGATIVE CEREBROSPINAL FLUID SHUNT INFECTIONS

Bruce A. Kaufman, MD, Julie Kim, MD, Ram Yogev, MD, David G. McLone, MD, PhD (St. Louis, MO)

All Gram negative shunt infections (N=19) treated from 1986 to 1990 at Children's Memorial Hospital (Chicago) were retrospectively reviewed. Average age at presentation was 3.4 years (47% < one year old, 37% ≧ five years old). Eighty four percent occurred less than 4 weeks after a previous shunt revision (average 10 days). Prophylactic intravenous antibiotic (Clindamycin) had been used in 80%. The most frequent symptoms were fever (63%), lethargy/irritability (63%), and wound/tract infection (32%). Abdominal symptoms or signs were present in only 22%. The initial Gram statin was positive in 44%. E. coli was the predominant, isolate (53%); mixed Gram negatives were found in 16% (none with E. coli). Ventriculitis was detected in 75%; those with mixed infections had significantly higher CSF protein values, and E. coli infections had higher CSF cell counts. All patients were treated with immediate shunt removal, externalized ventricular drainage (EVD), intravenous antibiotics, and complete shunt revision at internalization. Positive Gram stain, elevated CSF protein and decreased glucose values on admission were associated with continued positive cultures. In 22%, failure to promptly become culture negative necessitated additional treatment (EVD revision and/or intraventricular antibiotics). CSF values during treatment were highly variable; glucose values change minimally, protein values return towards normal. Cell counts were very erratic, perhaps due to clumping of WBC's or EVD catheter direct trauma. No patient suffered a relapse of their initial infection. A second infection developed

30. GRAM NEGATIVE CEREBROSPINAL FLUID SHUNT INFECTIONS (continued)

in 25% (3/4 with S. epidermidis, 3/4 acute presentation). Neurological morbidity was 13%, mortality was 5%. Gram negative shunt infections can be effectively eliminated with minimal morbidity and mortality, although secondary infection remains a problem. Patients with risk factors for difficult to treat infection remains a problem. Patients with risk factors for difficult to treat infections can be identified at admission. allowing for a more prompt and aggressive treatment plan.

31. THE USE OF THE SURGICAL ISOLATION BUBBLE SYSTEM IN SHUNTS

Sarah J. Gaskill, MD, Arthur E. Marlin, MD (Durham, NC)

Shunt infection continues to be a major problem in the treatment of hydrocephalus today. The results of a study of the surgical isolation bubble system (SIBS) are presented here as a method of reducing operative shunt infections. The SIBS is a disposable, presterilized, lightweight surgical draped designed to minimize infection. When attached to a blower it provides a continuous supply of Class I microbiological air to the operative field while isolating the wound and instruments from the outside environment. The blower and filter system use high efficiency particulate filter with a 99.97% efficiency in removing particles as small as 0.3 microns in size. As bacteria tend to be 0.4 to 20 microns in size, this unit has the potential to decrease shunt infection rates.

Presented here is an non-randomized prospective analysis of shunt procedures performed between 1986 and 1988. There were a total of 280 shunt procedures performed on 158 patients. The bubble was used in patients under twenty kilograms. 144 of these procedures were done in the bubble and 136 procedures were conducted in the usual fashion. The infection rate in the non-bubble group was 5.8%, and in the bubble group 3.5%. While the difference in infection rate is not statistically significant detailed analysis of the infections suggest that the bubble reduces infection rates. These results suggest that a larger prospective randomized study is warranted.

32. COMPLICATIONS OF VENTRICULOPERITONEAL SHUNTING FOR HYDROCEPHALUS ASSOCIATED WITH VEIN OF GALEN MALFORMATIONS IN CHILDHOOD

Steven J. Schneider, MD, Jeffrey S. Wisoff, MD, Fred Epstein, MD (New Hyde Park, NY)

Vein of Galen malformations are rare lesions which present in early childhood. Obstructive or communicating hydrocephalus, attributed to acquired aqueductal stenosis or venous hypertension respectively, is seen in a significant number of these patients. When the hydrocephalus is severe or progressive, a ventriculoperitoneal shunt is usually recommended.

Between 1982-1989, 38 children with Vein of Galen malformations were treated, 20 (53%) of whom required ventriculoperitoneal (V-P) shunts for hydrocephalus. Seventy per cent of these patients experienced postoperative complications which include status epilepticus (3 patients), intraventricular hemorrhage (7 patients) and subdural fluid accumulations, (5 patients). Representative case summaries will be presented. This experience has now prompted the authors to administer prophylactic anticonvulsants prior to surgery, and to place higher resistance frontal V-P shunts.

From 1982-1989, 38 children with Vein of Galen malformations were treated at NYU Medical Center. Thirty patients were treated by embolic procedures alone, while seven were managed with a combination of embolization and surgery. Neuroradiologic studies included cranial ultrasound evaluations, CT or MRI scans, plus cerebral angiograms.

33. FLOW CYTOMETRIC ANALYSIS OF PLEOMORPHIC XANTHOASTROCYTOMAS

Robert C. Rostomily, MD, John Hoyt, MD, Mitchel S. Berger, MD, Peter S. Rabinovitch, MD, PhD (Seattle, WA)

Flow cytometry (FC) of PXA's has not previously been published but potentially could provide insight into their biological behavior. We reviewed 10 specimens from 9 patients with suspected PXA's (ages 6-44, mean 18) to correlate histologic features with FC characteristics. All patients are living with mean survival time of 3.6 years (range 6 mos. - 1 yrs.). One patient had recurrence at 7 years after resection and radiation.

All specimens displayed moderate to marked cellularity, prominent pleomorphism, multi-nucleated giant cells and xanthomatous cells with rare mitoses. 3/10 samples had necrosis. GFAP staining was positive diffusely (7/10) or focally (3/10). Reticulin staining was seen in 7/10 specimens. 5/10 specimens were felt to definitively represent PXA's (PXA group) while 4/10 varied in one histologic characteristic (variant group) and the one recurrent sample was felt to have progressed to glioblastoma.

Flow cytometry showed aneuploidy in 4/10 samples (1/5 PXA group and 3/4 variant group and the recurrent specimen) and tetraploidy in 1/10 (PXA group). S. phase fractions (SPF) ranged from 1.5 -12.7 with similar mean SPF in aneuploid and diploid (6.7 and 5.3, respectively). DNA content ranged from 2.0-4.3n. High SPF, (10.6-12.7%) were found in all ploidy and histologic categories. No discernible correlations could be drawn between the FC data and the histologic groups identified.

33. FLOW CYTOMETRIC ANALYSIS OF PLEOMORPHIC XANTHOASTROCYTOMAS (continued)

Whereas FC has prognostic and therapeutic significance in other pediatric cerebral neoplasms, for PXA, prognosis and subsequent therapeutic decisions should still be based on clinical and histologic features alone. The demonstration of high SPF in these relatively slow-growing neoplasms is surprising and correlates with the incongruity between their anaplastic histologic features and less ominous biological behavior.

34. CYTOGENIC FINDINGS IN PEDIATRIC BRAIN AND SPINAL TUMORS

William M. Chadduck, MD, Jeffrey R. Sawyer, PhD (Little Rock, AR)

Fifty-three surgical specimens of pediatric brain and spinal cord tumors were submitted for cytogenic studies. Successful analysis was possible in 49, indicating the reliability of the cell culture and banding techniques. Thirty-one specimens had normal karyotyping. Twenty-two patients with gliomas (5 cerebellar astrocytomas, 5 gangliogliomas, 3 oligodendrogliomas, 3 brainstem gliomas, 2 optic gliomas, 2 spinal astrocytomas, 1 supratentorial glioblastoma multiforme, and 1 thalamic glioma) had normal chromosomes, Three of these 22 had anaplastic tumors with normal chromosomes, and all three remain without progression of disease by CT or MRI, 15-33 months after treatment. In contrast, three "benign" gliomas had abnormal chromosomes; one was a pleomorphic xanthoastrocytoma, a tumor of unpredictable biologic behavior; one, a desmoplastic gliofibroma in a neonate with extensive disease, and the third, a hypothalamic glioma, progressing within six weeks by CT scanning. Otherwise, benign astrocytomas and gangliogliomas consistently had normal chromosomes. Patients with both pathologically classified malignant tumors and abnormal chromosomes, uniformly were resistant to treatment and died promptly. The results indicate correlation of cytogenetic findings with both histopathology and patient outcome. Eight of 15 tumor specimens with abnormal chromosomes had been exposed to radiation prior to assessment, and four of these had had normal chromosomes in specimens obtained before therapy. Progression of chromosome abnormalities

34. CYTOGENIC FINDINGS IN PEDIATRIC BRAIN AND SPINAL TUMORS (continued)

were noted in five tumors (2 medulloblastomas, 1 pontine glioblastoma, 1 meningioma, and 1 metastatic Askin's) following radiation therapy. A role of radiation in the development of cytogenetic abnormalities was demonstrated, indicating that caution must be exercised in interpreting evolution of chromosome abnormalities. Specified cytogenetic findings in a wide variety of tumors will also be presented.

35. EXPRESSION OF GLIAL SPECIFIC ANTIGENS AND GROWTH FACTOR EXPRESSION I GLIAL TUMORS OF VARIED MALIGNANCY

Benjamin Warf, MD, Timothy Mapstone, MD (Cleveland, OH)

Understanding changes needed to initiate and maintain glial tumors is rudimentary. Recent work has focused on aberrations of growth factor metabolism and expression of cell surface antigens attempting to identify consistent changes which may elucidate the abnormalities needed for tumor development.

This project reports the expression of three glial antigens and four growth factors in a range of glial tumors (glioblastoma to astrocytoma) carried as tumor explants.

Specimens were harvested at surgery and immediately cultured. After 6 - 11 passages preconfluent cells were fixed and underwent immunostaining for glial markers. mRNA expression was measured by RNA-RNA hybridization. 5 GBM, 2 AA, and astrocytomas were analyzed for GFAP, A2B5, 7B11 and the growth factors, platelet derived growth factor A + B and transforming growth factor beta.

GFAP, an intermediate filament specific for glia, was strongly positive in all explants. 7B11, a newly described surface glycoprotein with unknown function was in all but one tumor. Its expression was heterogenous with respect to malignancy. 7B11 is specific for immature glial cells and is lost in rats by the 3rd postnatal week. A2B5, another surface glycoprotein, was in all tumors but more stongly represented in less malignant tumors. A2B5 is seen on 0-2A progenitor cells and remains in type 2 astrocytes but disappears in oligodendrocytes.

35. EXPRESSION OF GLIAL SPECIFIC ANTIGENS AND GROWTH FACTOR EXPRESSION I GLIAL TUMORS OF VARIED MALIGNANCY (continued)

PDGFA was in all tumors with higher levels in malignant tumors. PDGFB was only in malignant tumors (5/7). There appears to be an inverse correlation between A2B5 expression and PDGF mRNA levels.

TGFB was in all tumors with heterogeneous expression levels. It did not correlate with glial marker antigenic expression.

Expression of these glial antigens, is not related to malignancy. Except for A2B5 expression they do not appear to be driven by PDGF or TGFB. The implications for our understanidng of the changes required for development and maintenance of glial tumors and therapeutic alternatives will be discussed.

36. PROLIFERATIVE POTENTIAL AND OUTCOME IN GLIAL TUMORS OF CHILDHOOD

Michael Prados, MD, Hendrikus G.J. Krouwer, MD, Michael S.B. Edwards, MD, Takao Hoshino, MD, DMSc, David Ahn, PhD (San Francisco, CA)

The correlations between proliferative potential and outcome was evaluated in pediatric patients (pts) with glial tumors. Forty-three pts (28 male, 15 female), median age 10.7 yrs (range 1.1-18.2 yrs) were studied with bromodeoxyruiding (BUdR) between June 1984 - October 1988. Pathological diagnoses included low-grade glioma (LG) in 25 pts, anaplastic glioma (AG) in 13 pts, and glioblastoma multiforme (GBM) in 5 pts. Pts with JPA were excluded. Median BUdR-labeling indices (BUdR-LI) were < 1% (range 0-9.3), 2.3% (range 0-21.2) and 7.7% (range 0-21.3%) respectively. All pts had surgery, 37 pts also had either chemotherapy and/or radiation therapy. Median survival (MS) in LG and AG has not been reached (median follow-up 185 wks and 71 wks, respectively); 22/25 pts with LG and 8/13 pts with AG are alive. For GBM, 3/5 pts expired at 4, 14 and 101 wks; 2 are alive at 70+ and 240+ wks. Correlating MS with BUdR-LI, 7/8 pts with a BUdR-LI > 5% have died. Pts with a BUdR-LI < 1% or 1-5% have not reached MS, with 19/22 and 12/13 respectively (median follow-up 165 wks and 120 wks respectively). A significantly increased risk of shorter survival with increasing BUdR-LI was found (p=00001; Cox proportional hazards model). Survival also correlated with histology, being shorter for pts with GBM (p=.019). Age, sex and treatment were not significant predictors of outcome.

36. PROLIFERATIVE POTENTIAL AND OUTCOME IN GLIAL TUMORS OF CHILDHOOD (continued)

We conclude that BUdR-LI is a singificant predictor of outcome in pediatric pts with gilal tumors, and appears to be a stronger predictor than histology for LG and AG tumors. More pts need to be studied to confirm these preliminary observations.

37. EXPRESSION OF THE MULTIPLE DRUG RESISTANCE GENE, mdrl, BY PEDIATRIC PNET

David M. Tishler, MD, Corey Raffel, MD, PhD (Los Angeles, CA)

Pediatric primitive neuroectodermal tumor is a central nervous system malignancy currently treated with surgery, radiation therapy, and chemotherapy. Despite aggressive management, tumor recurrence will occur in almost half of all patients. Drug resistance by tumor cells may, in part, explain poor outcome. Resistance to chemotherapeutic agents may be related to expression of the multiple drug resistance gene, mdrl, and its protein product, P-glycoprotein.

The role of mdrl in 16 PNET was investigated using western blot analysis to detect expression of p-glycoprotein, mRNA polymerase chain reaction to detect mdrl mRNA expression, and Southern blot analysis to assess gene amplification. Analysis of protein extracted from 15 tumors revealed that 2 of 15 patients expressed detectable levels of P-glycoprotein. Polymerase chain reaction of RNA from 12 PNET revealed that 6 of 12 patients (4 of 10 de novo tumors and 2 of 2 recurrent tumors) expressed mdrl mRNA. Southern blot analysis of DNA from 16 PNET revealed that mdrl expression was not due to gene amplification. This is the first report of expression of mdrl in pediatric brain tumors. These data suggest a possible role for mdrl in de novo and acquired drug resistance in PNET of childhood.

38. INDUCED DIFFERENTIATION OF MEDULLOBLASTOMA IN TISSUE CULTURE: A MODEL TO STUDY DIFFERENTIATION AND ONCOGENESIS

John Ragheb, MD, P. Ebert, MD, J. Chandler, MSIV, M. Salcman, MD, (Baltimore, MD)

Medulloblastoma, the second most common pediatric brain tumor, is composed of sheets of uniform small round cells occasionally mixed with astrocytic and/or neuronal type cells. When grown in tissue culture medulloblastoma will differentiate spontaneously over several months into neuronal or astrocytic type cells. Medulloblastoma therefore appears to arise from a pluri-potent stem cell that has failed to differentiate during development.

Human medulloblastoma cell lines started from our patient and the TE671 cell line have been stimulated to differentiate both morphologicallly and antigenically using dibutryl-cAMP, phorbol diacetate, and hexamenthylene-bisacetamide. These cells differentiate along either a neuronal or astrocytic pathway. The neuronal like cells develop long bidirectional processes and are neurofilament (NF) antigen positive but are glial fibrillary acidic protein (GFAP) antigen negative by immuno-histochemical techniques. The astrocytic-like cells develop multiple fine cytoplasmic processes that are GFAP positive and NF negative. The phenotypic changes are complete in 3 to 5 days and are associated with an arrest in logarithmic cell growth. The differentiation process appears stable once complete even in the absence of the differentiating agent.

38. INDUCED DIFFERENTIATION OF MEDULLOBLASTOMA IN TISSUE CULTURE: A MODEL TO STUDY DIFFERENTIATION AND ONCOGENESIS (continued)

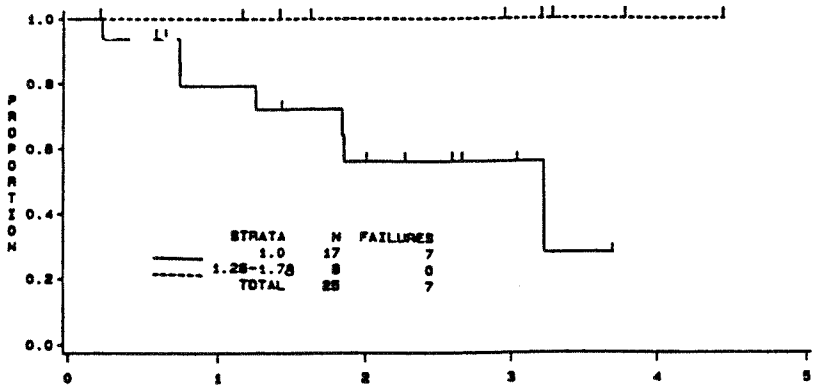
This evidence supports the concept that medulloblastoma represents the abnormal proliferation of a pluri-potent stem cell. We will discuss how this model is being used to study the molecular control of differentiation and to explore the role these developmentally regulated genes may play in oncogenesis in medulloblastoma.

39. CELLULAR DNA CONTENT IS PREDICTIVE OF EARLY RELAPSE IN MEDULLOBLASTOMA

Robert A. Sanford, MD, E.C. Douglass, MD (Memphis, TN)

To assess the prognostic value of cellular DNA content (DI) in medulloblastoma, we prospectively performed flow cytometric analysis on tumor tissue from 25 children with medulloblastoma (24 at initial diagnosis, 1 at relapse). Kaplan-Meyer analysis (Fig. 1) demonstrated a significant survival advantage for those 8 children (Group 1) whose tumors contained only hyperdiploid cells (DI-1.26 to 1.78) compared to the 17 children (Group 2) whose tumors contained a diploid stemline (DI=1.0) (at 2 years P=0.026, log rank).

TIME FROM DIAGNOSIS TO DISEASE PROGRESSION —DNA INDEX



The two groups were otherwise comparable in T-stage, M-stage, extent of resection and age:

	%T2	%T3a	%T3b	%M1	%Total resect.	Age (years)
Grp 1	50	12	38	25	38	2-11 (med=6)
Grp 2	30	17	53	12	53	1-19 (med=5)

Although the patients were treated on several different protocols, all received craniospinal irradiation for primary treatment of their tumor.

DI is a reproducible and reliable parameter that can be mobtained on almost every tumor. Even though the number of patients in this study is not large, our results indicate that DI is potentially an important prognostic factor for early relapse of medulloblastoma. Measurement of DI should be prospectively included in groupwide therapeutic studies of medulloblastoma.

40. THE P53 GENE AND PNET

Corey Raffel, MD, PhD, David M. Tishler, MD, Luis Lopez, MS, Leonard S. Sender, MD, Kenneth I. Weinberg, MD (Los Angeles, CA)

Two types of genes have been demonstrated to be important in oncogenesis. Oncogenes are dominantly acting genes: one copy of an oncogene in a cell may lead to transformation. Recessive oncogenes or tumor supressor genes act to limit cell proliferation. Inactivation by mutation or deletion of both alleles of a tumor suppressor gene removes a block to cell proliferation and may lead to transformation. Deletions of genomic materal in tumors is indirect evidence for the presence of a tumor suppressor gene in the deleted material. I have previously demonstrated that such a deletion occurs on 17p in PNET. The gene encoding p53, a known tumor suppressor, has been mapped to 17p. The DNA isolated from 14 PNET was examined for p53 gene rearrangements using Southern blotting with a p53 cDNA probe. No gene rearrangements were identified. RNA was isolated from ten tumors and the size of the mRNA for p53 was determined by Northern blotting with a cDNA probe. One tumor had no detectable p53 message, and one tumor had an mRNA smaller than normal, suggesting mutations in both p53 alleles and occurred in these two tumors. To further assess mutations in p53, the technique of polymerase chain reaction was used to amplify cDNA derived from the mRNA of two tumors known to have deleted the short arm of chromosome 17. The resulting cDNA was then sequenced. Preliminary data indicate that point mutations had occurred in the remaining p53 allele in both tumors. These mutations map to the highly conserved portion of the p53 protein. Similar mutations have been shown to inactivate the protein in other tumor types. These date indicate that mutations in the tumor suppressor gene, p53, may be important in the oncogenesies of PNET.

41. LATE PRESENTING AQUEDUCTAL STENOSIS

Thomas S. Berger, MD, William S. Ball, MD, Kerry R. Crone, MD, Erin C. Prenger, DO (Cincinnati, OH)

The purpose of this paper is to review nine older children who presented with symptomatic hydrocephalus (headache, gait disturbance) initially feels to be consistent with aqueductal stenosis. There were no eye signs other than papilledema on initial evaluation, specifically there were no sings of involvement of the quadrigeminal plate-periaqueductal area. Two patients (one in the pre-CT scan era) developed eye signs consistent with a lesion in the quadrigeminal plate five and twelve years later. Mass lesions were identified by CT in one and MRI in the other patient. Both lesions were surgically removed and were astrocytomas on pathologic examination. In seven other patients, we have now identified by CT and/or MRI abnormalities in the quadrigeminal plate region. We well present the CT and MRI findings. Stereotactic biopsy in one was negative even though post-operative scanning showed the biopsy was taken from the lesion. At this time we do not know the significance of these abnormalities but suspect they may represent hamartomatous change around the aqueduct. We recommend that all older children with apparent aqueductal stenosis need an MRI scan as part of the initial evaluation and subsequent follow-up.

42. COLLICULAR PLATE GLIOMAS

William R. Boydston, MD, Robert A. Sanford, MD, Elizabeth Kirk, RN, MSN (Memphis, TN)

Gliomas that arise in the tectal region of the mesencephalon usually present with hydrocephalus secondary to occlusion of the aqueduct. A review of 486 brain tumors in children treated during a five-year period revealed 6 children with gliomas of the tectal plate. Also during this same time period, 2 young adults were treated. Three of the 6 children were shunted for hydrocephalus, presumed aqueductal stenosis, 6 to 8 years prior to establishing the diagnosis of tectal plate glioma.

No abnormalities were noted on the initial, incontrasted CT sans. The tumors are isodense without contrast enhancement which makes the CT diagnosis difficult. MR scan is diagnosted by demonstrating the characteristic enlargement of the tectum with increased density on T2 images. On T1 images density and gadolinium enhancement are variable. Pathological confirmation was obtained by open biopsy in 4 patients. A stereotaxic biopsy was performed on 2 children; 2 children were not biopsied.

Five patients were treated with radiation therapy at the time of diagnosis. One child was followed closely and subsequently irradiated after tumor progression. All patients in this series are alive and functioning adequately 2 to 10 years after the onset of symptoms.

CONCLUSION: Tectal gliomas are indolent tumors that infiltrate the periaqueductal area whose presenting symptoms may be aqueductal stenosis and hydrocephalus. The diagnosis must be suspected in children who present with delayed onset of aqueductal stenosis. Since the tumor biology is uncertain, the authors recommend close follow-up with CT and MRI scans and radiation treatment with documented tumor progression.

43. INTRINSIC TUMORS CONFINED TO THE MEDULLA: RESULTS OF AGGRESSIVE SURGICAL TREATMENT

Rick Abbott, MD, Fred Epstein, MD, Jeffrey Wisoff, MD
(New York, NY)

Over a five year period, forty children underwent surgery for lower brainstem tumors. A retrospective analysis has identified a unique subgroup with focal, intrinsic tumors of the medulla. Experience with four patients discloses that they have a specific and significant risk factors attendant to surgery. Preoperatively they have dysphagia, nausea with occasional vomiting, ataxia, and a diminished gag reflex. Two patients had unilateral VI nerve paresis, two had mild weakness in an arm and/or leg and one had dysesthesias in her hands. All had a "benign" tumor and an 85% + resection was accomplished in each patient. There was no surgical mortality. All had a diminished gag reflex postoperatively and three had associated dysphagia. Two of the patients are functioning at their premorbid levels while two are moderately disabled having required a gastrostomy as a result of recurring aspiration pneumonia. We have concluded that while it is technically feasible to operate on intrinsic medullary tumors with a low risk to life there is significant permanent lower cranial nerve dysfunction.

44. CEREBELLAR ASTROCYTOMA: VERY LATE RECURRENCE

A.L. Amacher, MD (Danville, PN)

Neurosurgeons anticipate a 0.95 cure probability following gross total resection of cystic cerebellar astrocytoma and 0.80 or better for microcystic Type A lesions. The juxtaposition recently of recurrence of cerebellar astrocytoma after 15 years (cystic original) and 30 years (microcystic original) symptom-free intervals promted investigation of our entire cohort from a rural, stable population of pan-European ancestry. This cohort extends from 1950 through 1980, to allow for at least 10-year follow-up. Extent of resection and post-operative therapies were unrelated to risk or recurrence. The longest symptom-free interval to recurrence was 37 years. Five of 7 recurrences became manifest after 10 years, three of these after 20 years. To date, no patient has had a second recurrence.

45. GANGLIOGLIOMAS: A 13 YEAR REVIEW

Souheil Haddad, MD, Arnold Menezes, MD, John C. Van Gilder, MD (Iowa City, IA)

Gangliogliomas are rare tumors. The natural history of the neoplasm itself and the accompanying seizure disorder are not fully elucidated.

A 13 year restrospective review of all gangliogliomas treated at our institution was conducted. Sixteen patients were identified, equally divided by sex. Twerlve were in the cerebral hemispheres, one in the hypothalamus and three in the spinal cord. The mean age at diagnosis was 16.5 years (ranging from 3 to 39 years). The mean age at symptom onset, however, was 9.3 years with a mean length of symptoms of 7.1 years. The most common presenting symptom was seizures (10 patients) followed by focal neurologic deficit (5 patients) and headache (1 patient).

Cerebral hemispheric tumors were more amenable than spinal neoplasms to total resection (75% v/s 33% respectively). This explains the better outcome of the former: 75% or 9 patients are tumor free after total resection. The other 3 had a partial resection, 2 have a stable residual tumor and one died a year after diagnosis in spite of radiation therapy. Of the patients wit spinal neoplasms one is tumor free after total resection. The other 2 had 2 operations each and radiation therapy, one has a progressing tumor and the other died. The patient with a hypothalamic tumor died 1.25 years post biopsy and radiation therapy.

Four of the eight patients who presented with a seizure disorder and who had a total resection are seizure free post operatively compared to none of the two who had a partial resection.

46. PITUITARY ADENOMAS IN CHILDHOOD AND ADOLESCENCE: RESULTS OF TRANSSPHENOIDAL SURGERY

Michael D. Partington, MD, Dudley H. Davis, MD, Edward R. Laws, Jr, MD (Rochester, MN)

Pituitary adenomas are uncommon in childhood. Thirty-six patients underwent transsphenoidal resection before their 17th birthday, between 1975 and 1988 at the Mayo Clinic. Fifteen had prolactin-secreting (PRL) tumors (41.7%), 16 had ACTH tumors (44.4%, including 2 patients with Nelson-Salassa syndrome), and 3 were secreting growth hormone (GH) (8.3%). Two patients had non-functioning tumors (5.6%). The majority of patients were girls (21, or 58.3%) and predominated in every group except ACTH-secreting tumors, where they accounted for only 37.5% of patients. The average age at the time of surgery was 14.7 ± 2.2 years, the youngest patient being 7.3 years old. ACTH-secreting tumors were associated with symptoms earlier than other tumor types: 6 out of 16 patients (37.5%) became symptomatic before 10 years of age, comared with 2 out of 20 (10.0%) of all other patients. Presenting symptoms primarily reflected endocrine dysfunction, with neurological presentation (field cuts) occurring in only 2 patients. Presenting symptoms primarily relfected endocrine dysfunction, with neurological presentation (field cuts) occurring in only 2 patients. There was no mortality. Significant operative morbidity included steroid-induced psychosis in 1 patient and 3 cases of long-term diabetes insipidus (2 transient). Pleurihormonal tumors were common, occurring in 5/14 PRL tumors (36%), all 3 GH tumors and 1/2 non-functioning tumors, or 25% overall. Long-term

46. PITUITARY ADENOMAS IN CHILDHOOD AND ADOLESCENCE: RESULTS OF TRANSSPHENOIDAL SURGERY (continued)

follow-up (ie. median > 5 years) revealed good control of PRL tumors, (although 5/15 patients had received post-opertive radiotherapy), contrasted with a 33% recurrence rate for ACTH tumors. The majority of patients had good endocrine, including reproductive, function. We conclude that: 1. Although pituitary adenomas occur primarliy in adolescence, Cushing's disease can occur at any age. 2. Transsphenoidal surgery is feasible and safe in this age group. 3. Pleurihormonal tumors occur more frequently than in adults. 4. Long-term control rates in PRL and ACTH tumors are probably similar to those seen in adults.

47. PROGNOSTIC SIGNIFICANCE OF AGE AND DEGREE OF SURGICAL RESECTION OF EPENDYMOMAS: THE BOSTON CHILDREN'S HOSPITAL EXPERIENCE

Peter McL. Black, MD, PhD, Elizabeth Healey, Nancy Tarbell, Patrick Barnes, William Kuspsky, R. Michael Scott, Stephen Sallan (Boston, MA)

Between 1970 and 1989, 29 patients with intracranial ependymoma were evaluated, treated, and followed at The Children's Hospital in Boston. All patients had surgical resection and 19 had postoperative CR of MR imaging. Postoperative radiation therapy was delivered to 25 patients to brain and spinal cord with a median tumor dose of 5360 cGy.

With a median followup of 82 months, the overall actuarial survival was 61% at 5 years and 46% at 10 years. The overall freedom from progressive disease (FFP) was 40% at 5 years and 35% at 10 years. Fifteen of 16 families were local: the median time to local recurrence was 22 months. There was only 1 spinal cord failure (3%)1; CSF cyrology was positive in one local failure.

The presence of gross residual disease on postoperative imagina and age at presentation were the most important prognostic variables. Analysis of 19 patients with postoperative imaging demonstrated a 75% 5 year FFP for the 9 patients with no gross residual disease compared to 0% FFP for the 10 patients with gross residual disease (p=0.03). Overall survival at 10 years for infants 24 months or younger at diagnosis was 0% compared to 62% for older patients (p=0.03).

47. PROGNOSTIC SIGNIFICANCE OF AGE AND DEGREE OF SURGICAL RESECTION OF EPENDYMOMAS: THE BOSTON CHILDREN'S HOSPITAL EXPERIENCE (continued)

In infants younger than 24 months, the use of postoperative chemotherapy to defer radiation therapy may be justified. For non-anaplastic ependymonas, complete surgical resection followed by local field high dose radiotherapy appears to offer the greatest chance for long term survival. With the markedly reduced survival for patients with radiologically apparent postoperative disease, aggressive surgery when possible and new therapeutic endeavors where further surgery cannot be safely done are warranted.

48. THERAPY OF CEREBRAL PRIMITIVE NEUROECTODERMAL TUMORS (PNETS) IN CHILDHOOD

H.E.Fuchs, W.J. Oakes, H.S. Friedman, S.C. Schold, B. Hockenberger, E. Halperin (Durham, NC)

PNETs are a group of tumors, most frequently seen in childhood, which are primarily composed of primitive, or relatively poorly differentiated neuroepithelial cells, occurring in a variety of locations within the central nervous system. Cerebral PNETs are almost invariably fatal, even after multimodality therapy including aggressive surgical resection, radiation therapy (RT) and chemotherapy, with only 2 of 17 children with PNETS surviving over 4 years from diagnosis, in a recent series reported by Tomita, et al.1 Over the last 7 years, we have treated 5 children with cerebral PNETS with surgical resection, hyperfractionated neuraxis RT, and cheomtherapy using cyclophosphamide (1 gm/m2 on 2 successive days) and vincristine (2 mg/m2 on day 1 of cyclophosphamide cycle), alternating with cisplatin (100 mg/m2) monthly for up to 2 years (cisplatin therapy was terminated with the development of ototoxicity and monthly therapy continued with vincristine and cyclophosphamide).

48. THERAPY OF CEREBRAL PRIMITIVE NEUROECTODERMAL TUMORS (PNETS) IN CHILDHOOD (continued)

PT	AGE	Tumor Site	Extent of Resectiona	Years From Diagnosis
1	4	medial temporal lobe	partial	6.5
2	7	anterior 3rd ventricle	gross tot.	3
3	11	right frontal lobe	gross tot.	4
4	5	left occipital lobe	gross tot.	4
5	18	left cerebral hemisphere	partial	2

a) Following surgery, all patients received hyperfractionated RT followed by chemotherapy with cylcophosphamide and vincristine, alternating with cisplatin monthly for up to 2 years.

b) Survival to date, disease free or without evidence of disease progression.

All patients are clinically stable off of therapy in follow up to date (mean 3.9 years, range 2-6.5 years) with patients 1-4 disease-free, both clinically and radiographically, and patient 5 clinically disease-free with a stable radiographic abnormailty of contrast enhancement on CT scan. This represents a significant improvement in the treatment of children with cerebral PNETS compared to previously reported results. There were no treatment failures in follow up as much as 6.5 years from diagnosis.

Tomita, T., McLone, D.G., and Yasue M.: Cerebral primitive neuroectodermal tumors in childhood. J. Neuro-Oncol. 6:233-243, 1988.

49. CRANIOPHARYNGIOMAS IN CHILDREN: LONG TERM FOLLOW-UP OF TREATMENT METHODS

James Anderson, MD, Arno Fried, MD, Jennifer Ahl, RN, Joseph Hahn, MD (Cleveland, OH)

The optimal management of craniopharyngiomas in children has long challenged the technical skill of the neursourgeon as well as the medical management of difficult endocrine problems that follow. Depending on the treatment used, the neuropsychologic issues can require significant input as well. In order to assess the results of different types of surgical approaches as well as adjuvant therapies, a series of 37 pediatric craniopharyngiomas at The Clevand Clinic Foundation were reviewed over a prolonged follow-up of up to 40 years. Both pre-microsurgical and post-microsurgical cases were included and the influence of technical advances analyzed.

The 37 children averaged 9.5 years old (range 1.5 years to 18 years) with 11 operated upon pre-microsurgical and 26 post-microsurgical. The follow-up of this group spanned 42 years with average follow-up of 8.5 years. A detailed epidemiologic, endocrine, neurologic and radiologic profile is given.

Biopsy and cyst drainage were used in 4 children with an average survival of 2 1/2 years and all requiring further surgery. There were 16 who underwent subtotal tumor resection; 9 who received post-operative radiation therapy and 7 without any radiotherapy. The subtotal resection with radiotherapy group had a prolonged survival with a mean of 12 years but eventually 80% died and presently 20% are alive. Two children who underwent radiotherapy had a fall in Karnofsky scores to below 40. The subtotal resection group without radiotherapy has had 30% survival but survival averaged 7 1/2 years.

49. CRANIOPHARYNGIOMAS IN CHILDREN: LONG TERM FOLLOW-UP OF TREATMENT METHODS (continued)

The gross total resection group (N=17) have been followed an average of 5 1/2 years since the trend was that these were operated upon more recently. Seventy seven (77%) percent of these children are alive with 23% dying of both tumor recurrence as well as post-op endocrine crises. The long term profile of these survivors is discussed.

The study points out the long follow-up required to analyze treatment for crangiopharyngiomas with many subtotal removals surviving in excess of 10-15 years. Total resection results in the best chance at long term cure (77%), however neuropsychologic problems may be present and significant family support must be present to deal with proper hormonal replacements without which can be life threatening. If total excision is not technically feasable, subtotal resection with radiotherapy can result in prolonged survival as well, often as long as 10-15 years, but the large group of these children will eventually die of their tumors.

50. FUSIFORM DILATATION OF THE CAROTID ARTERY FOLLOWING RADICAL SURGERY OF CHILDHOOD CRANIOPHARYNGIOMA

Leslie N. Sutton, MD, Debra Gusnard, MD, Derek Bruce, MD, Arno Fried, MD, Roger J. Packer, MD, Robert A. Zimmerman, MD (Philadelphia, PA)

A series of 31 children with craniopharyngiomas underwent initial surgery and attempt at total removal at the Children's Hospital of Philadaelphia between 1982 and 1990. Nine of the (29%) were found to have fusiform dilatation of the supraclinoid carotid artery (FDCA) either at the time of surgery for recurrence (1 patient) or on routine surveillance enhanced CT scan performed 6 - 18 months postoperativley (8 patients). The finding of carotid enlargement was confirmed in seven cases with magnetic resonance angiography and in one case with a formal anteriogram. Eight of the nine patients remains alive at a mean of 3.7 years after diagnosis. None have experienced hemorrhage or other symptoms referrable to FDCA, which is believed to result from surgical manipulation of the carotid artery.

51. INTRACAVITARY THERAPY FOR CYSTIC BRAIN TUMORS IN CHILDREN WITH 32P CHROMIC PHOSPHATE COLLOID

James A. Taren, MD, Terry W. Hood, MD, Brahm Shapiro, MD (Ann Arbor, MI)

32P chromic phosphate colloid (mean energy 0.7 Mev. T 1/2 14 days maximum tissue penetration 7.9mm) was installed in 17 patients (11 craniopharyngiomas that had failed conventional therapy, and 6 with diencephalic, brain stem, or posterior fossa lesions). Cysts varying from 2 to 44 cc were treated with doses calculated to deliver 20,000 to 40,000 rads to the cyst wall (assuming prolonged suspension in cyst fluid). 32P was introduced either by stereotactic CT-guided control, or through the injection port of a preciously inserted aspiration system. Multiple instillations were occasionally required. Cyst volume was determined by CT measurements and/or 99m sulfur colloid. Post instillation, multiprojection gamma camera bremsstrahlung images of the head, liver and spleen were obtained, and multiple 24 hour urine collections and blood samples were assayed for 32P radioactivity. The patinets have been evaluated by serial clinical neurologic examination and cranial imaging.

No acute or chronic side effects were observed. Bremsstrahlung imaging revealed 32P to be confined to the cyst in every case. No activity was discernable within the CSF, CNS, or reticuloendothelial system. Assay of blood and urine radioactivity demonstrated barely detectable quantities of 32P. Cyst fluid samples at intervals of 1 to 60 days (median 16 days) revealed radioactivity was not significantly above background,

51. INTRACAVITARY THERAPY FOR CYSTIC BRAIN TUMORS IN CHILDREN WITH 32P CHROMIC PHOSPHATE COLLOID (continued)

although localization of 32P in the cyst was demonstrated on bremsstrahlung images. This finding supports early fixation of 32P to the cyst wall; dosimetry should not be based on the assumption of uniform dispersal. Supression of cyst fluid secreation and cyst shrinkage with concomittant clinical improvement occurred in all cases. Long-term response has been sustained in cystic craniopharyngiomas (1-7 years) and lower grade gliomas. More short-lived benefits (less than 6 months) were observed in 2 out or 4 other lesions.

52. THE DEVELOPMENT OF CARCINOMA IN THE AGING MYELODYSPLASTIC POPULATION

Sarah J. Gaskill, MD (Durham, NC)

The bowel and bladder dysfunction of myelodysplastic patients clearly puts them at risk to develop carcinoma. Presented here are two cases of carcinoma in young myelodysplastic patients. Both patients are characterized by a relatively young age and highly malingnant or advanced carcinoma requiring extensive surgical resection and chemotherapy. One is a transitional cell carcinoma of the bladder, and the second a squamos cell carcinoma of the rectum. Each had slipped out of routine care in their adolescent years only to turn up years later with devastating and fatal illnesses. Two similar cases were found in a review of the literature.

The development of carcinoma in the defunctionalized bladders of paraplegics and quadraplegics is not rare. Even with meticulous bowel and bladder management programs infections occur. Additionally, the chronic irritation of catheterization has been demonstrated to be carcinogenic.

These facts suggest that even with current techniques of bowel and bladder management myelodysplastics remain at increased risk for the development of carcinoma. Preventitive measures must be introduced into this populations. This should included routine examination with careful attention to the high risks of developing rectal and bladder carcinomas. Counselling and yearly examinations to include visual inspection, cytological urinalyses and stool guaiacs should be performed. It is the responsibility of the physician to adopt these types of preventive measures in the management of myelodysplasia.

53. HEAD INJURED CHILDREN ATTENDING EMERGENCY ROOMS IN HOUSTON AND SCOTLAND

Michael E. Miner, MD, Bryan Jennett, MD, Ralph Frankowksi,MD (Columbus, OH)

The effect of head injuries on hospital workload was analyzed by compairing a consecutive series of 654 children (<15 years) who attended the emergency room of Hermann Hospital, Houston, with two Scottish series, one compised of 1720 children attending one hospital in Glasgow and a second comprised of 2118 children from 23 hospitals. Age and sex distribution was similar in all three series. Falls were a common cause of injury in both Glasgow and Houston (57% and 41%). Automobile accidents accounted for 43% of the injuries in Houston but only 6% in Scotland. Impaired consciousness reported or found on arrival, or a history of being unconscious, or amnesia were regarded as evidence of brain damage. This was found in only 11% and 7% in the two Scottish series, compared to 26% in Houston, wehre many patients had first been evaluated in other hospitals and presumably the more seriously injured were selected for referral. Half of the patients in both Houston and Scotland had scalp lacerations; headache, vomiting, and seizures were equally infrequent. Despite the differences in injury severity, skull x-rays were done more often in emergency rooms in the two Scottish series (80% and 58%) compared to Houston (40%); there 18% had a CT scan in addition to a skull x-ray and 3% were investigated by a CT scan alone while in the emergency room. Others had x-rays and CT scans after hospital admission. In Scotland, only 10% were admitted to the hospital compared to 32% in Houston; however, 45% of the Houston admissions were to a 24 hour observation ward.

53. HEAD INJURED CHILDREN ATTENDING EMERGENCY ROOMS IN HOUSTON AND SCOTLAND (continued)

This first report of children with head injuries attending an American emergency room confirms reports from Scotland. Many mildly injured children attend emergency rooms but are not admitted to the hospital. The impact that head injured children make on hospital workloads is significantly underestimated by surveys limited to admissions to hospital. The features of head injured children attending emergency the two countries were strinkingly similar in most respects.

54. ALL-TERRAIN VEHICLE INJURIES

David I. Levy, MD, Joseph M. Zabramski, MD, Harold L. Rekate, MD (Phoenix, AZ)

All-terrain vehicles (ATVs) gained popularity during the 1980s and have continued to be a major source of pediatric morbidity and mortality. Many parents see these 3- and 4- wheel vehicles with soft balloon tires as toys with little potential for harm.

We reviewed the pediatric population admitted for ATV accidents from January 1986 to June 1990. Twenty patients ages 6 to 18 years, (mean age, 14 years) sustained injuries requiring hospital admission. Six patients had an admission Glasgow Coma Scale score of less than 12. There was one death. Folllow-up established that 8 of 19 (42%) surviving patients continue to complain of chronic problems originiating from their accident.

Our date indicate that 4-wheel ATVs are less dangerous than the outlawed 3-wheel variety. However, despite assurances by ATV manufacturers of the safety of the 4-wheel vehicles, significant injury was observed in patients riding these vehicles.

55. PENETRATING CRANIOCEREBRAL TRAUMA AND GUNSHOT WOUNDS IN 16 CHILDREN: A REPORT OF 16 CASES

Lynn Rogers, MD, Andrew D. Parent, MD (Jackson, MS)

This paper discusses a series of 16 pediatric patients treated at the University of Mississippi Medical Center in a 5 year period between February, 1985 and July, 1990. Eleven (68%) of these patients were male and five (31%) were female. All patients in this series were less than 16 years of age with an age range from 11 months of age to 15 years of age. Alarmingly, 8 (50%) were less than 10 years of age. These 16 patients were divided into 2 groups for comparison. These patients were divided into a younger age group ranging from 11 months of age to 8 years of age. The second group consisted of an older group ranging from 12 years of age to 15 years of age. In the 12 to 15 years of age group, there was a mortality rate of 50% compared with the mortality rate of only 12% for the younger age group. This difference in the mortality rate is probable related to the mechanism of injury. In the younger age group, ranging from 11 months to 8 years of age, all injuries were reportedly accidental and involved low velocity gun shot. In the older age group 12 to 15 years of age, 50% of these injuries were the result of self-inflicted wounds or assault. In the remaining 50% or injuries in this older age group, the circumstances of the injury were not certain. Despite this difference in the mechanism of injury, this marked disparity in the mortality rate between these two age groups raises the question of whether the plasticity of an immature brain may alter the mechanism of secondary brain injury which results from a penetrating brain injury. Outcome among the survivors of this series is discussed with a minimum follow-up of 9 months. The surgical and medical management of these injuries are briefly discussed as well as a brief discussion of the complications encountered in our series.

56. BURST FRACTURE: DELAYED VERSUS EMERGENT SURGERY

Robert A. Sanford, MD, Greggory Ricca, MD (Memphis, TN)

Burst fracture is a term coined to describe a traumatic cranial injury unique to young children. The pathophysiology seems to be a rupture of the intracranial contents through the skull as a result of major trauma. The skull x-ray is diagnostic for a widely separated linear skull fracture with outward expansion of the bone. Initial CT scan confirms the skull pathology and demonstrates a low density area beneath the scalp. This low density is too early for edema and is uncharacteristic of blood. The suspicion of cerebral tissue should be aroused.

Surgical exploration reveals ruptured dura and herniated brain tissue beneath the scalp. If the operation is performed shortly after the injury the neurosurgeon faces the problem of dural repair in the setting of increased intracranial pressure with herniated, edematous brain tissue. This may necessitate sacrificing viable cerebral tissue to obtain adequate dural closure.

The authors recommend delayed surgery. A fiberoptic, intracranial pressure monitor (Camino) is placed in the child admitted to the ICU. The child is intubated and the usual methods of controlling intracranial pressure are employed. In 4 to 10 days after the intracranial pressure is normalized, a standard craniotomy is performed with debridement of necrotic tissue and dural repair. Since these injuries are the result of major trauma including motor vehicle trauma and child abuse, the delay allows the identification and treatemnt of associated major injuries and anemia that may increase the risks of an emergent craniotomy. The authors will present 3 illustrative cases.

57. PRIMARY REPAIR OF OPEN DEPRESSED SKULL FRACTURES WITH BONE REPLACEMENT

James B. Blankenship, MD, William M. Chadduck, MD, Frederick A. Boop, MD (Little Rock, AR)

Opinions vary regarding the advisability of replacing calvarial fragments following debridement of open depressed skull fractures in children. Although it is recognized that bone removal often necessitates subsequent cranioplasty, it has been argued that replacing free fragments of contaminated bone fosters an unacceptable risk or wound infection. Our experiences with 31 consecutive pediatric patients, treated for compound depressed skull fractures, indicates that primary wound debridement with bone replacement can be done safely and obviates the need for secondary operations. The average age of our patients was 8.6 years. Injuries varied from motor vehical accidents, assaults, gunshot wounds, to having been kicked by a horse. All but 1 of our patients were operated within 16 hours of injury. Seven patients had relatively clean wounds; the rest were contaminated by hair, soil, or both. The dura was torn in 15 cases, with contusions or lacerations of the brain in 4. Following examination, all patients were assessed by skull radiographs and CT scans. Intravenous antibiotics (Nafcillin and Claforan) were started immediatley and continued for 5 days. Surgery consisted of meticulous wound debridement; bone fragments were scrubbed and soaked in Bacitracin solution prior to replacement, either singly or in a mosaic pattern. When needed, additional split thickness bone grafts were obtained from

adjacent calvaruim to complete coverage of the defects. Wound irrigation with Bacitracin solution preceded standard scalp closure. Follow-up of 30 cases averaged 26.5 months. All patients has satisfactory cranioplasty. There were no instances of wound infection of osteomyelitis. Replacement of bone fragments at the time of initial repair is advised regardless of the degree of contamination, unless an established infection is present.

58. CUSTOM FITTED THERMOPLASTIC MINERVA JACKETS IN THE TREATMENT OF CERVICAL SPINE INSTABILITY IN PRESCHOOL AGE CHILDREN

Sarah J. Gaskill, MD, Arthur E. Marlin, MD (Durham, NC)

The options for cervical spine stabilization have traditionally been the Minerva jacket or halo brace. In the preschool age child both of these devices have significant drawbacks. The halo brace because of ersoion and difficulty providing adequate fixation due to the thin calvarium of the young child, and the Minerva jacket because of its bulk and weight. With the advent of polyethelane plastics, Minerva jackets are a more viable option without the disadvantages noted above.

Six cases of cervical spine instability in preschool age children treated with a custom molded Minerva jacket are presented. In two of these cases the jacket was used after difficulties with the pins in the halo brace. All patients achieved cervical spine stability with minimal morbidity. One case had minor skin breakdown from the chin piece which has since been redisgned. Molding techniques and fitting are discussed. Pre and post treatment radiographs are shown. Most modern custom brace shops are capable of providing a custom fitted Minerva jacket. This technique is recommended as an alternative to the halo brace as it provides reliable and satisfactory treatment of these difficult problems in preschool children.

59. MANAGEMENT OF AXIS FRACTURE IN VERY YOUNG CHILDREN

Yoon S. Hahn, MD, John Ruge, MD (Maywood, IL)

The management of C2 fractures includes skeletal traction with bedrest for reduction and alignment. Stablization can be achieved by either internal or external fixation or a combination of both. These conventional treatments pose unique problems in pediatric population: skeletal traction is often not possible because of the relatively thin skull and when the skull is non-rigid as found when sutures are not yet closed. Furthermore, young children will often not tolerate complete bedrest.

From 1979 to 1989 there were 14 very young children with C2 fracture who were initallly manged by external halo orthosis to provide the initial reduction, alignment and effect a long-term stabilization. The ages ranged from 9 months to 8 years with an average of 3.9 years. There were 8 males and 6 females. The majority had Type II odontoid fracture (12 type II, 1 type I & 1 type III). Nine children were injured by fall and 4 by motor vehicle accidents. Four of the 9 children by "Fall" were injured in a "jungle gym" or on the playground. Eleven (78.6%) of 14 presented with only regional pain or muscle spasm. Three children (21.4%) showed lateralizing neurological deficit(s).

In the follow up periods, (1-10 yrs, avg. 6.5 yrs) 11 (78.6%) were completely intact neurologically; 2 children who were quadriplegic initially remained so, and 1 child has a very minor neurological deficit. No children deteriorated.

59. MANAGEMENT OF AXIS FRACTURE IN VERY YOUNG CHILDREN (continued)

The complications of halo orthosis were minor: pin site reaction in 4 (2 required respositioning or the pin), 1 halo frame damage, and 1 accidental halo pin displacement. No osteomyelitis or CSF leakage were noted.

Twelve (86%) of 14 children had complete restoration of alignment and fusion with halo orthosis alone. Only 2 children after initial halo placement required posterior cervical fusion during the first week after trauma to optimize reduction and alignment. Post-operatively, they were maintained in their external fixation.

Most axis fractures in children can be managed successfully with early halo orthosis with minimal complications. A subset of children will require initial surgical fusion. However, we feel that the majority of axis fractures in children can be managed with halo orthosis.

60. PEDIATRIC SPINAL INJURY

Mark Hamilton, MD, S. Terence Myles, MD (Calgary, Canada)

Injury to the spinal column and spinal cord is relatively infrequent in the pediatric population. We present a review of pediatric spinal injury in Southern Alberta, Canada, over a 14 year period. The admission records of the 3 University of Calgary hospitals that provide neurosurgical care for Southern Alberta and records of the Provincial Medical Examiners Office were reviewed. Patients 17 years or younger were included.

We identified 171 children accounting for 5.3% of the spinal injury population. There were 17 patients 0-9 years of age, 36 between 10-14 years and 118 patients 15-17 years of age. Eighty-four children (49%) sustained neurological injury and 20 (12%) had spinal cord injury without radiographic abnormality (SCIWORA). Thirty-seven patients (22%) had complete cord injury.

Injurty patterns varied with age. In the 0-9 year group, falls and pedestrial MVA accounted for 82% of injuries; 5 children (30%) sustained injury at C1-C2; 12 patients (70%) sustained neurologcial injury and SCIWORA occurred in 7 (41%). In the 15-17 year group MVA accounted for 63% of injuries; 9 patients (8%) sustained injury at C1-C2; 62 patients (52%) sustained neurlogical injury and SCIWORA occurred in 8 (8%).

Outcome was quite variable after spinal cord injury. Twenty-eight children (74%) with complete injury had significant recovery and 22 (58%) had complete

60. PEDIATRIC SPINAL INJURY (continued)

recovery. However, only 4 patients (11%) with complete injury had significant recovery and there were no complete recoveries. Three patients died in hospital. The Medical Examiner identified an additional group of 61 children that had sustained spinal injury at the time of their death. Further analysis of this subgroup of children and comparison with an adult cohort is in progress.

61. NEUROLOGICAL OUTCOME AFTER SPINAL CORD INJURY WITHOUT RADIOGRAPHIC ABNORMALITIES

Curtis A. Dickman, MD, Joseph M. Zabramski, MD, Harold L. Rekate, MD, Volker K.H. Sonntag, MD, FACS (Phoenix, AZ)

Spinal cord injury without radiographic abnormality (SCIWORA) occurs primarily in the pediatric population but is less common than other forms of spinal injury among children. Between 1972 and 1990, 159 pediatric patients were admitted to the Barrow Neurological Institute with acute traumatic spinal cord ofd vertebral column injuries. Of these, 26 (16%) children sustained SCIWORA. The mechanism of injury, its severity, and the prognosis for recovery were related to the patient's age. In young children, SCIWORA accounted for 32% of all spinal injuries and tended to bre severe; 70% were complete injuries. In older children SCIWORA accounted for only 12% of the spinal injuries, was rarely associated with a comple injury, and had an excellent prognosis for complete recovery of neurlogical function. As with other types of spinal cord injuries, the severity of neurological injury was the most important predictor of outcome. Patients with complete neurological deficits from SCIWORA had a poor prognosis for recovery of neurological function.

62. INTRAOPERATIVE MEASUREMENT OF SPINAL CORD BLOOD FLOW DURING TETHERED CORD RELEASE

Steven J. Schneider, MD, Alan D. Rosenthal, MD, Burt M. Greenberg, MD (New Hyde Park, NY)

Neurologic deterioration in the tethered cord syndrome has been attributed to compromise of blood flow in the distal spinal cord. In order to evaluate vascular perfusion in human subjects, we employed laser-Doppler flowmetry to continuously monitor the microcirculation of the distal spinal cord during surgery for tethered spinal cords in three children. Concurrent monitoring of anal sphincter by electromyography (EMG) and spinal somatosensory evoked potentials (SSEP) were also performed.

Three children, ages 3, 6, and 10 years, had progressive neurologic deficits which included weakness, numbness, and sphincteric dysfunction. All had lumbosacral lipomas and tethered spinal cores documented preoperatively on MRI studies. Surgical decompression included distal laminectomies followed by durotomy. The laser-Doppler disc probe was applied to the dorsal surface of the distal spinal cord for continuous monitoring during the untethering and lipoma resection with the CO2 laser. End tidal CO2, mean atrial pressure, and body temperature were kept constant during the monitoring period. Initial spinal cord blood flows which ranged from 8 to 15 ml/min/100 gr tissue (avetrage 12 ml/min/100 gm tissue) increased following untethering of the distal cord and

ranged from 18 to 42 ml/min/100 gr tissue (average 32 ml/min/100 gr tissue). No significant alterations were seen following resection if the residual lipoma with the CO2 laser. Intraoperative sphincter EMGs and SSEPs remained unchanged. All patients demonstrated neurological improvement postoperatively.

Improvement in distal spinal cord microcirculation occurs during surgical release of the tethered spinal cord. This may represent an important mechanism in the pathophysiology of the tethered cord syndrome.

63. CT, MRI, AND THE PATHOLOGICAL SUBSTRATE OF INTRACTABLE EPILEPSY IN CHILDHOOD

Glenn Morrison, MD, Antonio R. Prats, MD, Maria C. Penate, RN (Miami, FL)

There is a multiplicity of causes of seizures in childhood. However, when the seizures become intractable, a structural lesion must be sought. The use of computerized axial tomography (CT) and magnetic resonance imaging (MRI) have greatly facilitated this quest. But how accurate, sensitive, and/or specific are these neuroimaginhg studies?

More than a hundred patients with intractable epilepsy have been studied with CT and MRI. Of this group, 74 children have had 128 opeations and 53 cortical resections have been performed on 50 patients. These 50 children are the basis of this report.

No specimen was reported as normal. Ectopic neurons were reported in 17 and gliosis in 17 (not mutually exclusive). There were 12 tumors (5 gangliocytomas, 2 gangliogliomas, 3 hamaratomas, 1 oligodendroglioma, and 1 meningioma). Neuronal changes were common (heterotopia 5, loss 4, degeneration 2). Miscellaneous abnormalities included 2 vascular malformations, 2 vasculitides, 5 infarcts, 2 porencephaly, 2 cortical dysplasia, and 2 sclerosis (1 tuber).

Of particular note is a subgroup of 17 children with NORMAL preoperative CT and MRI who demonstrated pathological changes in the resected specimens. Ten showed ectopic neurons, 3 neuronal degeneration, 2 neuronal heterotopia, and 2 gangliocytomas. In 10 of this subgroup gliosis was also reported.

63. CT, MRI, AND THE PATHOLOGICAL SUBSTRATE OF INTRACTABLE EPILEPSY IN CHILDHOOD
(continued)

Thus it can be stated that in every case where a specific epileptogenic focus could be indentified and resected, the cortex was structurally abnormal. In 34% of the cases, however, the preoperative CT and MRI were judged to be normal and, therefore, at this time, these studies can not be relied upon to accurately predict the pathological substrate of intractable epilepsy in childhood.

64. THE JUVENILE DIFFUSE AVM: A NEW SUBTYPE OF VASCULAR MALFORMATION

Lawrence Chin, MD, Corey Raffel, MD, PhD, J. Gordon McComb, MD, Ignacio Gonzalez-Gomez, MD, Steven Giannotta, MD (Los Angeles, CA)

In a review of our series of cerebral AVM, a group op patients harbouring atypical AVM with a characteristic angiographic and histopathologic appearance was identified. Unlike the typical AVM, these lesions contained normal cerebral tissue between the abnormal vessels. We have named this AVM subtype the juvenile diffuse AVM to idicate the affected age group and angiographic appearance of the malformation. Our series currently contains eight patients with a mean age of 17.5 years. Six patients presented with an intracerebral hemorrhage, one with headache without hemorrhage, and one with ischemic symptoms compatible with vascular steal. Cerebral angiography revealed a large AVM in each case; three were 4-6 cm in diameter, and 5 were >6 cm in diameter. Characteristic angiographic features included multilpe small arterial feeders, small ectatic vessels in the malformation itself, multiple small draining veins, and a diffuse, puddling appearance of the contrast agent. MR scans obtained in two patients suggested that the brain between the vessels of the AVM was normal. Despite 10 operations in seven patients, complete resection of the AVM was accomplished in only three. Three patients received sterotaxic radiotherapy, one primarliy and two for residual malformation after surgery. Pathologic specimens contained small abnormal vessels interspersed amongst normal appearing neurons and white matter. Gliosis was noted in some cases.

In summary, the juevenile diffuse AVM is a subtype of AVM that occurs in young patients. They tend to be large lesions. Because the intervening neural tissue is normal, total resection cannot always be accomplished as the risk of severe neurologic deficit is high.

65. USE OF MR ANGIOGRAPHY IN CHILDREN

Nesher G. Asner, MD, William C. Olivero, MD, William C. Hanigan, MD, Robert M. Wright, MD (Peoria, IL)

Over the past six months, we have used magnetic resonance angiography (MRA) to evaluate 20 children with suspected cerebrovascular disease. Images were obtained with a 1.5 Tesla Siemen's superconducting magnet using three-dimensional fast imaging with steady-state precession techniques. In all cases, T1- and T2- weighted cerebral MRI's were also obtained.

Ages ranged from 4 days to 18 years with a mean age of 5.4 years and a median age of 3.2 years. There were 13 boys and 7 girls. Children less than 10 years were given sedation with chloral hydrate. The average acquisition time was five to ten minutes.

Reasons for examination fell into four groups. Four patients had head or neck trauma with suspected vascular injury. Four patients had other studies suggestive of cerebrovascular abnormality. Four patients had infarcts or atrophy. Eight patients had miscellaneous reasons. Three patients had undergone ECMO.

Thirteen studies revealed normal vessels. Four MRA's resulted in direct changes in patient management. MRA results obviated the need for conventional angiography in six cases. Two MRA's were contradicted by follow-up conventional angiography.

We found MRA most useful in evaluating patients with suspected traumatic vessel injury, in patients with suspected CT abrnomalities, and in assessing venous sinus patency. MRA may replace conventional angiography in certain disease states in children, where conventional angiography is difficult and sometimes associated with high risk. The sensitivity and specificity of MRA relative to conventional angiography are not know at present.

66. PREOPERATIVE EVALUATION AND TEMPORAL LOBECTOMY IN CHILDREN WITH CHRONIC EPILEPSY

P. David Adelson, MD, Warwick J. Peacock, MD, Youssef Comair, MD, Harry Vinters, MD (Los Angeles, CA)

Due to advances in neuroimaging techniques, subtle lesions in the mesial temporal lobe have been detected with increasing frequency in children with seizure disorders. In our series of 27 children who underwent temporal lobe resection, 25 had seizures. The average age of onset was 3.5 years with the average interval to surgery of 4.5 years. Twenty patients underwent properative computerized tomography (CT), 25 had magnetic resonance imaging (MRI), and pisitron emission tomography (PET) was done in 15. Electreoencephalography was obtained in 254 cases while angiography was performed in 10. Postoperatively, 13 cases (48%) were diagnosed with one or more tumors, which inclueded low grade astrocytoma (6), hamartoma (5), ganglioneuroma (3), and primitive neuroectodermal tumor (1). One or more structural or cytoarchitectural abnormalities were found in 12 cases (44%): Dysplasia (9), neuronal heterotopia (4), arteriovenous malformation (2), and porencephalic cyst (1). Preoperative CT accurately revealed pathology in 60% of patients studied, while MRI was predictive in 77% and PET indicated abnormalities in 100% of children tested.

The elimination of seizures through early surgery had been noted to improve developmental outcome in children with seizures. Thus, prompt detection and precise localization of neoplasms or other lesions in the pediatric populations

66. PREOPERATIVE EVALUATION AND TEMPORAL LOBECTOMY IN CHILDREN WITH CHRONIC EPILEPSY (continued)

should allow for optimal surgfical management and seizure control. Analysis of preoperative assessments, pathologic diagnosis and surgical outcomes in chronic epilepsy had led us to conclude that the pediatric patient must be considered different from the adult. Our preoperative evaluation and pathologic findings will be discussed in relation to this changing view.

67. MULTIMODALITY PREOPERATIVE EVALUATION OF CHILDREN FOR EPILEPSY SURGERY

Leslie D. Cahan, MD, Clarence S. Greene, Jr, MD, Perry Lubens, MD (Orange, CA)

Neursourgical treatment of medically intractable epilepsy in infants and children is quite different from seizure surgery in adults and adolescents. Seizure semiology, preoperative evaluation, underlying pathology and operations performed are quite distinct in this age group.

Reliance solely on interictal scalp EEG to characterize and localize partial seizures is particularly unreliable in infants and children. A multimodality evaluation which includes structural tests (MR and CT imaging), functional tests (PET, SPECT) and seizure telemetry can identify patients who are goodf surgical candidates for epilepsy surgery. Three cases illustrative of the relative values of each modality will be presented:

1. An infant with seizures from birth and hemimegalencephaly. While interval EEG's suggested extension of interictal findings to the contralateral hemisphere, MR and PET scans showed unilateral abnormalities. Hemisoherectomy had led to cessation of seizures and resolution of the contralateral EEG abnormality.

2. A patient with infantile spasms and unremitting seizures for 18 months of life. EEG showed widespread left hemisphere abnormalities. MR studies suggested cortical dysplasia in the left occipital lobe. PET scans showed ictal hypermetabolism in the left occipital and temporal lobes. Resection of the occipital and temporal lobes significantly lessened the seizure frequency and severity.

3. An 8 year old child with long history of complex partial seizures. Scale EEF (including ictal recordings) were lateralizing but not localizing; CT, MR, PET, and SPECT all suggested unilateral occipital focus (Sturge Weber without facial angioma). Focal resection has led to cessation of seizures.

In infants and children:

(a) Developmental anomalies of the brain are more frequent surgical targets than mesial temporal sclerosis.
(b) Interictal scalp EEG amy suggest a generalized disorder while MR, PET and SPECT may reveal that focal resections will be helpful.
(c) Some patients with infantile spasms (previously thought to be a generalized seizure disorder), may in fact be good surgical candidates.

68. HEMISPHERIC TUMORS IN CHILDREN ASSOCIATED WITH EPILEPSY: HISTOPATHOLOGY OF RESECTED SEIZURE FOCI

Mitchel S. Berger, MD, G. Ojemann, MD, W. Pilcher, MD, S. Ghatan, MD (Seattle, WA)

As many as 40 to 60% of children with hemispheric tumors will present with seizure activity, which is often difficult to control medically. Our experience with this population of patients has led us to analyze the anatomical relationship of seizure foci to the tumor nidus, and, to review the seizure foci histology and follow-up in terms of seizure control with resection of the tumor and adjacent epileptongenic foci.

Electrocorticography (ECoG) is performed using a combination of surface and stip electrodes, or via a subdural electrode array inserted one week prior to the tumor resection. Functional localization of hemispheric sites, e.g., language, motor, sensory, is accomplished when necessary using stimulation mapping techniques. Seventeen children and adolescents were retrospectively analyzed. Three of these patients were well controlled preoperatively with anticonvulsants and were excluded from the analysis. The remaining 14 patients had persistent seizure activity. Thirteen of these children had post resection ECoG, of which 9 patients had further resectión of eplieptic foci based on these recordings.

In 11 of 14 patients, no tumor was identified histologically in the resected seizure foci. No ECoG active sites were found intraopearatively in two children,

68. HEMISPHERIC TUMORS IN CHILDREN ASSOCIATED WITH EPILEPSY: HISTOPATHOLOGY OF RESECTED SEIZURE FOCI (continued)

and, in the remaining patient, the epileptogenic focus was withing the Rolandic cortex and biopsy of this revealed sparse tumor infiltration. Three patients with a seizure history were first operated on at an outside institution without ECoG, and, due to persistent seizures postoperatively, underwent reoperation with ECoG revealing seizure foci that were removed, and, were free of tumor. All patients with ECoG identifiable seizure foci undergoing resection for tumor and elipeptic foci are seizure free 7 to 80 months, postoperatively. Anticonvulsants were rountinely tapered and discontinued 6 to 9 months after surgery. Patients with seizure without definitive ECoG foci remain seizure free following tumor removal alone without anticonvulsants.

In summary, epileptogenic foci, when examined histologically, are void of tumor infiltration. When these foci are resected, superb control of clinical seizures without the used of anticonvulsants can be expected, thus emphasizing the need for ECoG during tumor surgery.

69. EPILEPSY SURGERY IN CHILDREN WITH BRAIN TUMORS

Arno Fried, MD, Jennifer Ahl, RN, Elaine Wyllie, MD, Issam Awad, MD, Jospeh Hahn, MD (Cleveland, OH)

Intractable epileptic seizures are a common childhood problem with many of these children being evaluated for epilepsy surgery. Many of these children harbor a variety of structural lesions including brain tumors. The best results must include considerations to curing the epilepsy as well as removing the tumor. The profile of tumors associated with epilepsy are discussed as well as the relationship between seizure focus and tumor location. Methods for working out the exact seizure focus including a variety of invasive monitoring techniques in children is discussed. These invasive monitoring techniques also allow brain mapping in functioanl areas to optimize the resection of a tumor and seizure focus.

In a larger pediatric epilepsy monitoring and surgery program, 32 children with intractable epilepsy and brain tumors were managed with mean follow-up of 3.5 years (7 months to 6.5 years). All had failed maximum medical therapy and had imaging studies showing a tumor. The majority were in the temporal lobe 80%, with extratemporal foci also seen (frontal lobe 10%, parietal 5% and occipital 5%). Tumor types included gangliogliomas 40%, low grade astrocytomas 18%, oligodendrogliomas 14%, higher grade astrocytomas 6% as well as several more uncommon tumor types.

In order to determine the seizure focus, a phase I monitoring of prolonged video-surface EEG recording was done. An intermediate phase of invasiveness

using PEG epidural electrodes and foramen ovale electrodes were occasionally used to improve the delineation of an epileptic zone. When a seizure focus had to be better defined or functional mapping performed prior to resective surgery.

The results of monitoring workup and resection strategies included three groups: Group 1) seizure focus and tumor in same location, Group 2) seizure focus contiguous with tumor but extends beyond 2 cm from the tumor and Group 3) seizure focus remote from the tumor. The goal of surgical resection was removal of tumor and seizure focus but the areas of the brain involved detemined the actual resection strategy.

When both tumor and seizure focus could be completely resected, over 90% had seizures controlled. In cases where either the tumor or seizures focus could not both be completely resected, removal of the lesion resulted in better seizure control (75%) despite incomplete seizure focus resection. The major value of the seizure mapping was in identification of seizure foci that were contiguous with the tumor but not extened beyond it and could be removed with the lesion. Furthermore, when the lesion could not be completely removed, seizure focus mapping and resection of accessable areas of focus or tumor often resulted in good outcome.

This study concludes that 1) seizure focus was often found immediately around the tumor and resection of both resulted in excellent seizure control; 2) seizure foci

69. EPILEPSY SURGERY IN CHILDREN WITH BRAIN TUMORS (continued)

could extend beyond 2 cm of the tumor and resection of both had better than 80% seizure control; 3) when possible, resection of both seizure focus and tumor is preferable to excision of the tumor alone; 4) in cases where the tumor cound not be resected radically, a subtotal resection of lesion and/or seizure focus was possible after monitoring a mapping. The surgeon should try and plan for tumor treatment as well as control of epilepsy.

1. PEDIATRIC INTRACRANIAL ANEURYSMS: CONVENTIONAL AND SPECIALIZED TREATMENT

James M. Herman, MD, Harold L. Rekate, MD, Robert F. Spetzler, MD (Phoneix, AZ)

Compared to adults, intracranial aneurysms are rare in children. Between 1984 and 1990, 15 children 19 years or younger with intracranial aneurysms were treated at our institution (9 males and 6 females; mean age, 8 years; range, 4 months to 19 years). The presentation, treatment, and outcome of these 15 children were evaluated to characterize the group and to assess the efficacy of new management srategies. Subarachnoid hemorrhage (SAH) precipitated admission in 9 cases, and 6 children presented with symptons related only to the mass effect of the aneurysm. Seventy one percent of the aneurysms were located in the anterior circulation, and 29% were located posteriorly. There were 6 solitary saccular, 3 giant, 3 myotic and 3 traumatic aneurysms. Four children had multiple aneurysms. Preoperatively 7 children required a ventriculostomy. Twelve cases were treated by direct clip obliteration, one of which required hypothermic cardiac arrest. Of the reamining 3 cases, 2 were managed by alternative methods and one patient died before surgical intervention. Post-operative vasospasm was documented in 7 patients: all 7 received hyperperfusion and 4 received calcium channel blockers. Most pateints who presented with only neural compression improved (90%); the outcome of patients with SAH varied (excellent, 3; good, 6: fair, 5; poor, 1). These data indicate that although pediatric aneurysms are infrequent and diverse, advances in the perioperative treatment of pediatric aneurysms have been successful.

2. ARTERIOVENOUS MALFORMATIONS IN CHILDHOOD: A REVIEW OF 29 CASES

Todd Lasner, Dan Heffez, MD, FRCS (Chicago, IL)

We reviewed the records of 29 children diagnosed at The Johns Hopkins Hospital over the past 10 years as having a racemose arteriovenous malformation (AVM) of the brain in order to determine whether the natural history of childhood AVMs differed from that reported in adults.

The mean age of our patients was 11.1 years. There was no sexual predisposition. 21/29 AVMs involved the convexity, deep nuclei or white matter of the cerebral hemispheres. 25/29 (86%) of the patients presented with acute hemorrhage vs 50% reported in adults. 9 patients had chronic headache or seizures prior to the time of diagnosis; 6 of these children ultimatley bled. There was no case of chronic ischemic neurlogic deficit due to a steal syndrome.

13/25 patients who presented with hemorrhage rapidly progressed to coma. If the ruptured AVM was not definitively treated, repeat bleed was the rule. (84% by 4 years follow-up bs. a projected rate of 12-15% for adults). The acute mortality rate of 8% (2/25) following hemorrhage was comparable to that reported in adults. However, 14 of 25 patients (56%) presenting with bleed were left with a persistent disabling neurological deficit or a depressed level of consciousness, (mean length of follow-up = 28 months). This exceeds the 30% morbidity related to bleed reported for adult patients.

Despite the retrospective nature of this review, the incidence of initial and repeat hemorrhage and of serious long term morbidity in children with AVMs is greater than that reported in adults and suggests that AVMs presenting in childhood are more aggressive lesions. These differences in natural history and their implications for the treatment of childhood AVMs will be discussed.

3. STAGED RESECTION OF ARTERIOVENOUS MALFORMATIONS IN CHILDHOOD AND ADOLESCENCE

Hillel Z. Baldwin, MD, Harold L. Rekate, MD, Robert F. Spetzler, MD (Phoenix, AZ)

An arteriovenous malformation (AVM) diagnosed during childhood presents a difficult problem when considering the lifetime risk of hemorrhage in this population. We present our experience with the surgical managenment of 22 patients harboring intracranial AVM's ranging in ages from 1 month to 18 years of age (mean 10.9) treated from 1983 to the present. AVM's were graded using the Spetzler classification ranging form 1 to 5 (mean 3). Three of these lesions were located in the posterior fossa, and the others were located in the supratentorial compartment including the hemispheres, thalamus, or pericallosal regions. Eleven (50%) of the patients presented with intraparenchymal or subarachnoid hemorrhage, 2 with congestive heart failure, and the remainder with varied neurologic complaints.

Nearly all (90%), of these lesions were successfully obliterated or excised in toto during staged procedures for intraoperative embolization and resection. The maximum number of stages was 5 with an average of 2 per patient. There was no intraoperative or perioperative mortality.

Outcome assessed using the Glasgow Outcome scale yielded 10 good outcome patients (46%) without deficit, 10 good outcome patients with mild deficits, and 2 moderate outcome patients who are functional with aid. These data support the operative resection and embolization of childhood AVM's that can be selectively staged, thereby decreasing the perioperative morbidity and mortality frequently attributed to alterations in cerebral perfusion pressure dynamics.

4. TREATMENT OF INTRACRANIAL AVMS IN CHILDREN USING THE GAMMA-KNIFE RADIOSURGERY

Joung H. Lee, MD, Ladislau Steiner, MD, PhD, Christer Lindquist, MD, Melita Steiner, MD (Charlottesville, VA)

A 20 year cumulative experience using the gamma-knife radiosurgery for treatment of AVMs in children is presented.

A total of 201 pediatric patients were treated since 1970. Subdividing this patient population, 89 (45M, 44F) patients belonged in the children group, ranging in age from 5 to 12 years old, and 112 (63M, 49F) patients were adolescents, 13 to 17 years of age. During the same period, a total of 998 patients harbouring intracranial AVMs (201 children, 797 adults) were treated.

Of the 89 patients in the younger group, 92.1% presented with hemorrhage, 0% with epilepsy, 3.9% paresthesia, 1.3% cranial nerve deficit, 1.3% headache and 1.3% had an incidental finding. In the adolescent group, 90.2% presented with hemorrhage, 6.9% with epilepsy, .98% paresthesia, .98% cranial nerve deficit and .98% headache.

Of the 201 patients in this series, 97 patients had a 2-year follow-up arteriogram. In the younger group, 87.2% had total obliteration, 6.4% subtotal obliteration and 6.4% partial obliteration. In the adolescent group, 86% had total obliteration, 2.0% subtotal obliteration and 12.0% partial obliteration. Subtotal obliteration is defined as angiographic delineation of early filling vein only with complete

4. TREATMENT OF INTRACRANIAL AVMS IN CHILDREN USING THE GAMMA-KNIFE RADIOSURGERY (continued)

disappearance of the nidus. Partial obliteration is defined as reduction in size of the nidus without its disappearance. Both subtotal and partial obliteration are considered as unsatisfactory results. Fifty-two patients were treated since January 1989, and therefore, these patients have not had any follow-up arteriogram.

In 2 patients (2.2%) in the younger group and 1 (.9%) in the adolescent group, hemorrhage occurred following gamma-knifre treatment, however before the AVM was noted to be obliterated. The overall incidence of bleeding following gamma-knife treatment in the pediatric population is found to be 1.5% (3/201), which is lower than that of natural course or that of the adult treatment population. Radiation-induced change in the brain tissue with neurological deficit was detected in 2 patients in the younger group, and in 4 patients in the adolescent group.

The results obtained with radiosurgery for AVMs in children are comparable to those of adult population, with the rate of total cure approaching 86-87%. Radiosurgery should be considered, in selected cases, as an alternative to microsurgery in management of intracranial AVMs.

5. THE CURRENT ROLE OF RADIOSURGERY IN CHILREN AND ADOLESCENTS

Dougles Kondzjolka, MD, L. Dade Lunsford, MD, Robert J. Coffey, MD, John C. Flickinger, MD (Pittsburgh, PA)

The ability to provide stereotactic focussed therapeutic radiation (radiosurgery), is especially advantageous in children and adolescents where whole brain fractionated radiotherapy carries significant risks. Currently, the indication and risks of radiosurgery in such patients are poorly understood. In order to examine the role of gamma knife radiosurgery, we analyzed our results with 52 patients (age 2-18 years), with arteriovenous malformations (AVMs) or brain tumors treated over a 36 month interval.

Children less than 14 years of age had stereotactic radiosurgery under general anesthesia. Radiosurgery was the primary treatment method for 29 children with AVMs, and for all five patients with acoustic neuromas (all had NF II). Radiosurgery was performed as adjuvant treatment for 7 patients with residual AVMs, and 10 patients with recurrent tumors (3 with pituitary adenomas, 3 with ependymomas, 2 with craniopharyngiomas, and 1 each with glioblastoma and meningioma). Radiation-related complications were seen in one patient; transient hemisparesis developed at the time of AVM obliteration of MRI. Complete angiographic obliteration was seen in 9 of 11 (82%) evaluable patients at 2 years. Arrest of tumor growth was obtained in all but two patients: one had glioblastoma and one required delayed resection of and acoustic neurinoma.

5. THE CURRENT ROLE OF RADIOSURGERY IN CHILREN AND ADOLESCENTS (continued)

Our current indications for radiosurgery in children and adolescents include primary treatment of inoperable or high-risk AVMs or acoustic neuromas (often in an attempt to preserve useful hearing), as adjuvant therapy for recurrent or residual benign tumors or AVMs, or as a boost to fracrionated radiotherapy for malignant tumors. Radiosurgery represents a low risk and frequently effective treatment tool for children with high risk AVMs (which may obliterate faster than in adults), or brain tumors. The potential to use radiosurgery in an effort to delay the administration of whole brain radiotherapy for young children with malignant tumors, remains to be explored.

6. CONGENITAL CHOROID PLEXUS PAPILLOMAS: DIAGNOSIS AND MANAGEMENT OF TWO UNUSUSAL CASES AND REVIEW OF THE LITERATURE

Michael J. Burke, DVM, MD, Ken R. Winston, MD (Denver, CO)

Choroid plexus papillomas account for 3% of pediatric intracranial tumors and 95% are diagnosed prior to age 12 years. The congenital nature of this lesion has long been suspected but reports of symptomatic tumors in neonates at birth are rare. There are 13 such reports, 10 males and 3 females; all were large tumors. The authors will present that literature and add two unusual cases, both in males. A discussion of the diagnosis and management involved in these two new cases is presented.

Both patients harbored small lesions (1 cm) in the choroid plexus at the level of the foramen of Monro. The first case presented antenatally with signs of unilateral hydrocephalus and ependymal changes. Hemorrhage occurred at the time of birth. The second case presented with hydrocephalus on the third day of life. Initial MRI in both cases revealed a hemorrhagic lesion at the level of the foramen of Monro and secondary unilateral ventriculomegaly. In each case, a transcallosal approach permitted complete excision of the lesion without complication or significant blood loss. Both patients required shunting for hydrocephalus during their hospital course. Both children are alive and well with no evidence of tumor a 1 year and 7 months respectively.

Congenital choroid plexus papilloma should be considered in the differential diagnosis of unilateral ventricular hemorrhage and/or asymmetric hydrocephalus in the fetus or near-term neonate. A high level of suspicion is required for early diagnosis and treatment and will continue to improve the prognosis in this benign childhood neoplasm.

7. SURGICAL MANAGEMENT OF BRAIN STEM TUMORS IN CHILDREN. REVIEW OF 62 OPERATED CASES

A. Pierre Kahn, MD, D. Renier, MD, C. Sainte-Rose, MD, J.F. Hirsch, MD (Paris, France)

From 1970 to 1988, 62 exophuyic or intrinsic non exophytic brain stem tumors were operated on in children, 32 without, 30 with CUSA. Gliomas were predominant (92%) and benign tumors (grade I and II) were majority. Removals were partial in 40 cases, subtotal in 14, total macroscopically in 8. Thirty one patients were irradiated post operatively (10 malignant, 21 benign tumors); 8 patients whose benign tumors were removed totally or subtotaly were not irradiated.

The conclusions are as follow:

1) The use of the CUSA both authorized more radical excisions and led to the reduction of the operative mortality (25% withouth CUSA, 4.5% with CUSA).

2) The prognosis of benign tumors was significantly better after subtotal or total removal than after partial removal (acturial survival rates: respectively 91% and 50% at 5 years).

3) Among the 7 clinico radiological parameters selected retrospectively and submitted to a stepwise logistic regression analysis, 2 were found to be highly correlated to the histological grading: age at operation (+/- 2 years) and presence of a peritumoral hypodensity (yes or not) on the CT scanner.

4) A systematic irradiation is not mandatory following radical excisions of benign tumors: indeed, none of the 8 patients whose tumor was removed totally or subtotally recurred post operatively (median follow up: 26 months).

8. RADIATION ASSOCIATED GLIOMAS AND MENINGIOMAS IN THE PEDIATRIC POPULATION: A REPORT OF FOUR CASES

Todd R. Ridenour, MD, Arnold H. Menezes, MD, Robert L. Schelper, MD (Iowa City, IA)

Aggressive treatment with chemotherapy and cranial irradiaiton has led to increased survival and "cures" in pediatric patients suffering from acute lymphocytic leukemia, medulloblastomas, and other lesions. With prolonged survival, delayed complications are being recognized, the most striking being subsequent development of intracranial neoplasms. An increased number of reports would implicate cranial irradiation as a causative factor for induction of secondary neoplasms. The possible role or various forms of chemotherapy remains unknown. We present four pediatric patients who developed secondary intracranial lesions.

Two patients developed malignant gliomas 6 and 7 years after being successfully treated with systemic cheomtherapy, along with cranial irradiation (2400 rads) and intrathecal methotrexate for central nervous system prophylaxis in the management of acute lymphocytic leukemia. The bulk of the malignant tumor was withing the maximal zone of speckled intracranial calcification. Histologic studies revealed tumor formation within regions exhibiting calcific vascular changes. One child is doing well 5 years follwing radical resection with subsequent radiation and chemotherapy. The other succumbed with widespread cranial disease. Two patients developed meningiomas 14 and 15 years after biopsy and irradiation for cerebellar medulloblastoma and low grade cerebellar fibrillary astrocytoma. These tumors occured supratentorially but within the port of radiation therapy. They were successfully resected.

8. RADIATION ASSOCIATED GLIOMAS AND MENINGIOMAS IN THE PEDIATRIC POPULATION: A REPORT OF FOUR CASES (continued)

Post-irradiation intracranial neoplasms, most prominent being meningiomas and gliomas, represent definite clinical entities. Their pathological and clinical characteristics and criteria for definition are reviewed along with the pertinent literature. Long-term follow-up of pediatric patients subjected to radiation and chemotheraphy is required.

9. TRANSYLABYRINTHINE APPROACH FOR AN ANTERIORLY EXTENDED PONTINE TUMOR

A. Pierre-Kahn, MD, A. Perrin, MD, J.F. Hirsch, MD (Paris, France)

Brain stem tumors are easily reached when they are exophytic posteriorly or laterally. The surgical approaches to be used depend upon the nervous structures involved. They are: the posterior fossa and the lumen of the fourth ventricle when the tumor bulges in the fourth ventricle; the retrosigmoid route when the tumor comes from the lateral aspect of the medulla and/or of the pons; the subtemporal approach when the lesion develops from a peduncle in the cisterns.

On the contrary, tumors originating from the pons and bulging anteriorly towards the clivus are much more difficult to reach and to remove. None of the previously mentioned routes are convenient: the posterior one because it would injure the floor of the fourth ventricle; the other ones because they would not allow an easy vision upon the whole volume of the tumor.

To reach a voluminous cavernous angioma located anteriorly in the pons, towards the clivus, the authors have used a transpetrosal, translabyrinthine approach. This unusual route allowed the authors to remove the entire lesion, but not to preserve the facial nerve, due to the narrowness of the operative field. The neurological follow up went uneventfull and the child, dramatically handicaped before opeation, was discharged in a considerable better neurological condition. The authors present a video film trying to emphasize the difficulties and advantages of such a route.

10. SUBDURAL EMPYEMA IN CHILDREN

Ronald Michael, MD, Francisco A. Guiterrez, MD (Chicago, IL)

Subdural empyema (SDE) series from the pre-antibiotic era reported mortality rates of nearly 100%. With the introduction of antibiotics and the CT scan, mortaltiy rates dropped tro 10-20%. Recent series report zero mortality. We reviewed SDE seen at The Children's Memorial Hospital between 1985 and 1989. Ages ranged from 6 weeks to 16 years and demonstrated a bimodal distribution with 6 infants and 2 adolescents. There were 7 males and 1 female. The infants presented with symptoms of meningitis whereas the adolescents presented with focal neurologic deficits. The cause of SDE in infants was meningitis and in adolescnets, pansinusitis. Diagnosis was facilitated with CT scanning which demonstratres the typical hypodense fluid collections surrounded by enhancing membranes. MRI performed for one patient was superior to CT for differentiation SDE from other intracranial lesions. All patients underwent surgery. Three infants had burr-hole drainage (including 1 failed anterior fontanell tap) and 3 had craniotomy. One patient required an EVD for transient hydrocephalus and one patient developed hydrocephaly which required shunting at a later date. Only one patient had repeat craniotomy. Five patients harbored H. infleunzae, 1 N. meningitis. The adolescents had S. aureus and a B. melaninognicus with a GpC streptococcus. All patients were treated initially with a broad-spetrum antibiotic regimen which was narrowed when the offending organism was identified. Outcome was excellent in most cases and there were no mortalities. Successful mangement of SDE demands timely diagnosis, evacuation of the subdural fluid (for diagnostic and therapeutic purposes) and the institution of appropriate broad-spectrum antibiotics.

11. LOCULATED SUBARACHNOID PUS: A COMPLICATION OF CHILDHOOD BACTERIAL MENINGITIS

W.B. Faircloth, MD. W.O. Bell, MD (Winston-Salem, NC)

Bacterial meningitis in the pediatric age group has the unique complication of extracerebral fluid collections. With advent of CT scanning these fluid collections are becoming more easlity identified and their treatment more controversial. At our institution 43 patients (average age 19.6 months) were admitted with bacterial meningitis over a 30 month period. All were diagnosed with lumbar puncture and culture and none were immune compromised. Ten patients (average age 8.5 months) developed extracerebral fluid collections during treatment: 9 Hemophils influenza, Streptococcus pneumoniae. In two of the patients the extracerebral fluid collections resolved with percutaneous drainage. Eight patients (includes the patient with pneumococcal meningitis) had persistent fevers, elevated white blood cell counts, or deteriorated neurologcially after 10 days of appropriate antibiotic therapy and underwent craniotomy. At surgery the surface of the brain was hyperemic, and purulent material was present in the subarachnoid space. No subdural fluid collections could be identified. During closure the dura was loosely approximated to allow drainage of the purulent material and cerebrospinal fluid into the extradural space. All eight of the patients improved and became afebrile by 48 hours postoperatively with continued antibiotic therapy. In conclusion we report the treatment of eight patients with bacterial meningitis that developed extracerebral fluid collections who had persistence of fever, elevated white blood cell count or neurologic deterioration on appropriate antibiotic therapy. The fluid collections are areas of loculated subarachnoid space that behave as a closed space infection more rapidly. We believe this is a previously unrecognized complication of meningitis that responds to surgical drainage.

12. EARLY SURGERY FOR BIRTH RELATED UPPER BRACHIAL PLEXUS INJURIES

John P. Laurent, MD, Saleh Shenaq, MD, Rita Lee, MD, Julie Parke, MD, Itzel Solis, MD, Lisa Kowalik, RN (Houston, TX)

One hundred consecutive children with birth related brachial plexus injury have been reviewed from Texas Children's Hospital Brachial Plexus Clinic. Twenty consecutive children with upper brachial plexus injuries were selected by the Team to have surgical reconstruction, in an attempt to improve the neurological outcome. The average age for operation was four months (1 month - 18 months). Neuromas were found in twelve children. Grafting to a functional nerve root with a saphenous nerve was completed in thirteen children. Neurolyusis of the neuroma was attempted in five children.

Functional improvement of the affected arm, after operation, was observed in 96% of the children. Children with bypass nerve grafts, and earlier age of operation progress more quickly towards neurological improvement.

13. NERVE ROOT COAPTATION IN AN INFANT WITH CERVICAL NERVE ROOT AVULSION

Shokei Yamada, MD, PhD, Gordon Peterson, MD, David Knierim, MD, Douglas Will, MD (Loma Linda, CA)

Various methods of neurotization have been performed as reconstructive procedures for cervical nerve root avulsion with little benefit. The authors recently have succeeded in functional restoration of shoulder girdle and arm muscles by coaptation of C3 and C4 anterior primary rami to the upper trunk of the brachial plexus in several adults with C5 and C6 root avulsion.

A 1-month-old girl who sustained C5-T1 root avulsion at birth presented with total paralysis of the left upper extremity. Coaptation of the C3 anterior ramus to the upper trunk of the brachial plexus was performed at 2 months of age. There was no trace of middle and lower trunk or medial cord. One month later, coaptation of the third intercostal nerve to the median nerve and fourth intercostal nerve to the ulnar nerve was performed. Within four months after the first surgery, the biceps contracted and EMG showed motor unit potentials in biceps, deltoid, triceps, flexor carpi radialis, extensor digitorum, hypothenar muscles and abductor pollicis brevis. Normal skin turgor and texture returned.

In adults the benefit of coaptation is limited to the proximal muscles, probably beacuse of the distance to distal muscles. In an infant, the distance from the shoulder to the wrist is about 20 cm, and regenerating nerves from the brachial plexus can reach the small hand muscles with a critical period of 6 months. The benefit achieved in this infant suggests that the coaptation procedures may be effetive in the treatmenet of nerve root avulsion in infants.

14. THE EFFECT OF MYELOMENINGOCELE CLOSURE ON URINARY FUNCTION IN NEONATES WITH SPINA BIFIDA

William O. Bell, MD, Lawrence Kroovand, MD. Lois J. Hart, MT, Kamron Y. Benfield, PAC (Winston-Salem, NC)

To determine the effect of myelomeningocele clousre on detrusor-sphincter coordination, we reviewed the medical records on 31 noenates with myelodysplasia and prospectively studied them with urodynamic assessment and renal ultrasonography prior to closure of the spinal defect, withing seven days of closure, and at three monthly intervals thereafter. All renal sonograms were normal both pre- and post-closure. Urodynamic evaluation demostrated synergistic activity in 18 neonates both pre- and post-closure. During prolonged follow-up one developed a flaccid pattern and four developed detrusor-sphincter dyssynergia. Eleven neontaed demonstrated a flaccid pattern and no external sphincter activity pre-closure. Ten of these neonates were unchaged on initial post-closure evaluation; for developed dyssnergia during follow-up. The final neonate in this group demonstrated a flaccid pattern with external sphincter dyssynergia and vesicoureteral reflux after closure. She subsequently developed a hypertonic detrusor, more severe reflux and upper tract deterioration. One child demonstrated detrusor-sphincter dyssnergia pre-closrure and a flaccid pattern with no external sphincter activity post-closure which was the consequence of surgical division of the neural placode during closure of the back defect. The final child demonstrated detrusor-sphincter dyssynergia both pre- and post-closure. This child developed a coordinated pattern during follow-up. Our study demonstrates that closure of the back defect in the neonatal period does apepar to adversely effect detrusor-sphincter coordination and reemphasizes the need for careful and regular follow-up in children with myelodysplasis to detect deterioration of the urinary tracts.

15. SACRAL RHIZOTOMY TO INCREASE BLADDER CAPACITY IN SPINAL CORD INJURY (ANIMAL MODEL)

Jogi V. Pattisapu, MD, Marion L. Walker, MD, N. Newberg, MD, Joe C. Cheever, MD, B. Snow, MD (Orlando, FL)

Spastic urinary bladder with urgency and incontinence is a frequent problem in patients with spinal cord injury. Many treatment modalties are available, including selective dorsal rhizotomy which has proven effective in many cases. Using a ferret spinal cord injury model, we determined the effectiveness of this procedure to increase bladder capacity, and to define the time parameters involved.

Sevene adult ferrest weighing (2.5 to 3.5 kg) were used in this study. After preoperative urodynamic and electrophysiologic studies, the animals underwent a T8-T10 laminectomy and transection the the spinal cord. Urodynamic studies were followed until the bladder volumes stabilized *8-18 weeks), and the animals underwent sacral selective dorsal rhizotomy. Bipolar stimulation of the posterior nerve rootlets was performed with intravesicular pressure recordings, lower extremity and external sphincter EMG monitorings. Rootlets which produced an abnormal contradiction of the bladder and lower extremities were identified and divided. The animals were followed for 6-16 weeks post rhizotomy until the bladder volumes stabilized.

Three animals obained a mild increase in bladder capacity (11 to 20 cc, 52 to 89cc, and 96 to 158cc). In three animals, the urinary bladder volumes were moderately

15. SACRAL RHIZOTOMY TO INCREASE BLADDER CAPACITY IN SPINAL CORD INJURY (ANIMAL MODEL) (continued)

increased (45 to 110cc. 103 to 225cc, and 100 to 250cc). One animal developed a significant increase in the bladder volume from 21cc to 210cc ten weeks post-rhizotomy. Each animal was allowed to serve as its own control, using the pre-lesion bladder volume as the baseline value, and awaiting until the bladder volume stabilized before the rhizotomy procedure.

Using a ferret spinal cord injury model, we confirmed the effectiveness of scaral rhizotomy in increasing bladder volumes. The timing of the observed changes was better defined, and this data offers insight into the future potential of the procedure to benefit spinal cord injury patients.

16. SELECTIVE SACRAL RHIZOTOMY FOR BLADDER SPASTICITY

Bruce B. Storrs, MD, William Kaplan, MD, Casimir Firlit, MD, David G. McLone, MD, PhD (Chicago, IL)

Over the past year, 6 patients have undergone selective sacral rhizotomy for control of bladder spasticity. All patients were referred from the urology service after clinical and systometrographic examinations demonstrated progressive increses in intravesical pressure and worsening reflux in the face of the best urological control.

Pathological bases for the bladder dysfunction were sacral agenesis in two patients, one male one female and myelomeningocele in four patients two male two female. Small bladder capacities, frequent wetting, high intracesical pressures, and severe reflux were present in all patients. All patients had been tried on medication for the bladder spasticity, and failed.

Intraoperative monitoring of bladder pressure, urogenital diaphragm EMG and bladder detrusor EMG were used to identify sacral rootlets that controlled detrusor contaction and influenced bladder pressures but did not effect the sphincteric system.

All six patients had a significant change for the better in their bladder function. All patients had an increase in bladder capacity, two previously incontinent patients attained continence without catheterization. The remaining four patients became dry between catheterizations. There were no complications.

17. INTRASPINAL ACCUMULATION OF SPINAL FLUID CAUSING CORD COMPRESSION IN CHILDREN WITH MYELODYSPLASIA SECONDARY TO MALFUNCTIONING VENTRICULOPERITONEAL SHUNTS

Robert M. Beatty, MD (Kansas City, MO)

Three children with myelodysplasia and shunted hydrocephalus developed neck and upper thoracic pain with resultant neurolgical deficits. The neurological deficits consisted of hypesthesia in the upper extremities and weakness of the upper extremities in two patients and in one patient decreased strength in the hands. These children were evaluated radiographically with magnetic resonance imaging which demonstrated displacement of the cervical and thoracic spinal cord due to cerebral spinal fluid within the spinal canal. These children underwent shunt tapping which demonstrated malfunctions shunt. In each of the children the shunt was revised and the symptoms immediately resolved with abatement of neck discomfort and improvement to resolution of the hypesthesia and motor function. The repeat MRI study demonstrated resumed central location of the spinal cord with diminished intraspinal CSF accumulation.

It is thought the shunt malfunction allowed egress of the spinal fluid within the spinal canal with compression of the spinal cord by the spinal fluid.

18. SILASTIC DURAPLASTY

William M. Chadduck, MD, Frederick A. Boop, MD (Little Rock, AR)

The role of scar formation in re-tethering of the spinal cord after surgical treatment of spinal dysraphism, has produced refinements in tchniques for closure of the neural tube. Silastic, because of its relatively inert property, has been used for duraplasty, but in a few reports its non-adherence was considered disadvantageous, contributing to hemorrhagic complications. In those instances the silastic dural grafts were large, and no technical modifications had been made preventively. We report 29 patients (7 myelomeningoceles, 6 tethered cords with dermoids or lipomas, 5 Chirari II malformations, 5 spinal cord tumors, 4 lipomyelomeningoceles, and 2 diastematomyelias) in whom silastic dural grafts were used to prevent adherence of neural structures to overlying tissue. Our surgical technique will be presented. The patients have been followed for up to six years. Only one patient became infected, was treated with antibiotics without graft removal, and has remained without sequelae for over three years. One patient had a pseydomeningocel, noted incidentally on follow-up MRI. There have been no hemorrhages, CSF leaks, or other complications from using silastic. Re-tetheing has not occurred. One patient with a spinal cord tumor has been re-operated for tumor recurrence; the non-adherence of the silastic membrane to the underlying neoplasm and irradiated spinal cord was clearly beneficial. Two patients have been re-studied by MRI, myelography, and.or real-time ultrasonography confirming non-adherence of the silastic to the intraspinal lesions. We conclude that the use of silastic dural grafting, with appropriate modifications in surgical technique, is safe and prevents re-tethering of neural tissues in a variety of spinal lesions.

19. RESOLUTION OF SCOLIOSIS IN PEDIATRIC CHIEF CHIARI MALFORMATIONS WITHOUT MYELODYSPLASIA

Michael G. Muhonen, MD, Arnold H. Menezes, MD, Paul D. Sawin, BS (Iowa City, IA)

Magnetic resonance imaging (MRI) has increased the awareness between scoliosis and neurogenic dysfunction. A prospective study was undertaken to investigate the assocation between hindbrain herniation and scoliosis. The degree and location of the curvature, the surgical results, and the follow-up progression of the curve were investigated in 16 children, age 1-15 years, who had surgical intervention for symptomatic Chiari malformations without myelodysplasia in the pst 5 years. 11 of the 16 had an associated scoliosis (range 15-44°, mean 28°). Four of the curves were to the left, and were rapidly progressing in 10 of the patients. Symptoms ranged from headache to myelopathy and sudden foot drop. Investigative procedures included standing spine radiography, and MRI of the brain, spinal cord, and cranial-vertebral junction. Eight of the children had an associated syrinx. Surgical interventional consisted of a posterior fossa decompression in all patients, and a transoral decompression of the cervical-medullary junction in five. All patients were followd at 3, 6, 12 month and yearly intervals with clinical evaluations and standing spine radiographs, and a single post-operative MRI. Ten of the patients had complete resolution of their preoperative symptoms, and 6 showed improvement. The scoliosis resolved in 9 of the 11 patients, stabilized in one, and worsened in one, a child with holocord hematomyelia. The reversal of scoliosis was seen as early as 3 months post-operatively. All patients under 10 years of age had resolution of their scoliosis within one year, despite preoperative curves of >40°.

20. SPINAL EPIDURAL HEMATOMA IN HEOMPHILIAC INFANT

L. Philip Carter, MD, Imre Noth, MS, III, Janet Pittman, MD (Tucson, AZ)

A 6 month old male with Factor VIII deficiency and seizure disorder presented to University Medical Center with flaccid paralysis of arms and decreased movement of legs. The patient developed fever and fussiness 4 days earlier. The following day, the patient presented at an outside ER and was cyanotic requiring mouth to mouth resuscitation. Following resuscitation, breathing resumed but patient was markedly. Upon admission to UMC, MRI study showed an epidural hematoma from C3 to T5. Conservative therapy with Factor VIII was initiated along with close monitoring. The patient began to show improvement imediately and conservative therapy was continued. By day 4, MRI repeat revealed a residual hematoma and the spinal canal was no longer compressed. Factor VIII level was up to 855. By discharge, the patient ws moving all extremities well and continued daily to improve.

Spinal epidural hematoma in hemophiliacs is rare. Only 7 unequivocal cases have been reported and only 2 previous cases of conservative management have been reported. Decompressive laminectomy has been the therapy of choice, but has carried a high mortality rate (68%).

This case demonstrates that immediate treatment with appropriate correction of clotting deficiency spinal epidural hematoma in an infant may be successfully treated without surgical decompression.

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