

Second World Conference of the International Study Group on Neuroendoscopy (ISGNE), Castel dell'Ovo, Naples, Italy, 11–13 September 2003

11 September, Thursday: 12.30–13.30

Session III A: Free presentations

Hydrocephalus: Indications and outcome

1
Neuroendoscopic treatment of pediatric hydrocephalus: dilemmas and controversies. A. Suri, S.P. Chandra, A.K. Mahapatra, V.S. Mehta (New Delhi)

Background: Pediatric hydrocephalus consists of a wide spectrum of disorders. The management of hydrocephalus in children has been a neurosurgical challenge and frustration for over two centuries. **Purpose:** The purpose of the study was to analyze the spectrum of pediatric hydrocephalus and to identify the efficacy of neuroendoscopic procedures in its treatment. **Methods:** One hundred and fourteen consecutive patients with pediatric hydrocephalus who underwent neuroendoscopic treatment from June 1998 to March 2003 were retrospectively analyzed. **Summary:** The group of patients with congenital/developmental hydrocephalus comprised 34 with congenital aqueductal stenosis, 6 with congenital foraminal stenosis, 7 with Dandy Walker cysts, and 20 with arachnoid cysts (10 suprasellar, 9 posterior fossa, and 1 quadrigeminal). Patients with congenital aqueductal stenosis underwent endoscopic third ventriculostomy with or without aqueductal stenting or aqueductoplasty with an 80% success rate (failure was seen in infants with a cortical mantle <1 cm or a previous shunt). Patients with congenital foraminal stenosis underwent endoscopic fenestration with 100% success. Patients with arachnoid cysts underwent cystocisternostomy and/or cystoventriculostomy with success in all cases. The treatment of the group of patients with acquired hydrocephalus consisted of successful relief of hydrocephalus using endoscopic third ventriculostomy with or without biopsy in 4 cases of tectal gliomas, 3 cases of posterior third ventricular tumors, 1 case of a tectal cavernoma, and 4 cases of posterior fossa tumors. Endoscopic fenestration was performed in 9 patients with multiloculated hydrocephalus, 9 patients with an isolated temporal horn and 6 patients with post-meningitic hydrocephalus. Endoscopic excision was successfully performed in 6 patients with colloid cysts and 5 patients with intraventricular neurocysticercosis. There was no mortality. The complications included 2 cases of cerebrospinal fluid (CSF) leak, 2 of meningitis, 2 of ventriculitis, 2 of subdural hygroma, 1 of transient Parinaud's syndrome, 2 of transient third nerve paresis, and 2 of transient hypothalamic dysfunction. **Conclusions:** The successful neuroendoscopic treatment of pediatric hydrocephalus depends on a proper understanding of its etiology, pathology, CSF dynamics and imaging characteristics.

2
Endoscopic third ventriculostomy: holes and hormones. M.G. Luciano, S.M. Dombrowski, M.H. Ragab, V. Gonugunta, S.K. Elbabaa, A. Hamrahian (Cleveland)

Objective: The notion that larger endoscopic third ventriculostomy (ETV) fenestrations will remain patent is intuitive, yet not proven. Unfortunately, a larger hole may bring a greater risk of hemorrhage or hypothalamic and endocrine injury. In this study, we compared patency and clinical success rate with size of fenestration based on intraoperative imaging. We also related size of fenestration to endocrine testing. **Materials and methods:** Preoperative imaging and intraoperative endoscopic pictures were used to evaluate third ventricle size, fenestration size and location, and third ventricle floor condition in 115 patients with hydrocephalus. Computer image analysis was used to express fenestration size as a percentage of the third ventricle floor. Clinical success was defined as symptom resolution without further procedures and patency determined by CINE CSF flow MRI and exploration in cases of failure. A subgroup of 35 patients underwent evaluation of their hypothalamic-pituitary hormonal axis including adrenal axis stimulation. **Results:** The highest patency was associated with a thin third ventricle floor ($p=0.001$), but neither fenestration size (within the range performed) nor location had a significant impact on patency rate ($p=0.27$ and 0.24 respectively). Large third ventricle size was associated with a large fenestration size ($p=0.001$) and thin floor ($p=0.025$), and therefore related indirectly to clinical success. The endocrine axes were normal on hormonal testing with the exception of a marginal decrease in dynamic adrenal axis response in four patients with fenestrations >29%. **Conclusions:** Third ventriculostomy patency is more likely to persist with a thin ventricular floor, but significantly related to neither size nor location of the fenestration. Large third ventricle is associated with thin floor and large fenestration size, hence indirectly with patency. The endocrine systems appear largely intact after third ventriculostomy, though small deficits seen in four patients with fenestrations >29% of the floor suggest potential vulnerability.

3
Different neuroendoscopic techniques for the treatment of hydrocephalus in children: a multicentric study in 360 patients. S. Portillo, G. Zuccaro, G. Fernandez Molina, A. Houssay, F. Sosa, O. Konsol, R. Jaimovich, J. Ledesma, M. Guevara, G. Ajler, P. Picco (Buenos Aires)

Materials and methods: We analyzed retrospectively 360 patients with different types of hydrocephalus treated endoscopically in four Neurological Pediatric Centers in Buenos Aires, Argentina. Statistical analysis was performed using Excel for Windows 98. The etiology of the hydrocephalus (H) was classified as noncommunicating H in 117 cases (32.5%), tumoral H in 66 cases (18.3%), multiloculated H in 47 cases (13.1%), H secondary to arachnoid cyst of the deep cisternal system in 31 cases (8.6%),

malfuction of the shunt in 30 cases (8.3%), H with myelomeningocele in 21 cases (5.8%), postmeningitis in 13 cases (3.6%), post intraventricular or subarachnoid hemorrhage in 7 cases (1.9%), and others types in 18 cases (5%). Three hundred and seventy-four procedures were performed in 360 patients: 1 patient underwent 5 procedures, 1 patient 3, and 8 patients 2. The procedures were 207 third ventriculostomies (55.3%), 70 fenestrations (18.7%), 48 catheter placements (12.8%), 26 ventriculo-cystostomies (6.9%), 11 septostomies (2.9%), 7 catheter retrievals (1.9%), 4 aqueductoplasties (1.1%), and 1 monoplasty (0.3%). *Results:* A successful outcome following third ventriculostomy should be defined as resolution of increased ICP without shunting, which occurred in 163 out of 207 (78.4%) cases. We had poor results in infants with myelodysplasia: 14 out of 17 patients required a shunt and 3 out of 4 postmeningitis. Surprisingly, the 7 patients with posthemorrhagic H did not require shunt placement after third ventriculostomy. Of the patients with tumoral H, 7 out of 51 cases with posterior fossa tumors needed a shunt, whereas none of the 12 patients with pineal tumors and 3 patients with ventricular tumors did so. In 26 out of 47 patients with multiloculated H a shunt was placed in addition to fenestration; however, only one catheter was necessary in all cases. Complications occurred in 16 out of 374 procedures (4.3%): diabetes insipidus in 3, transient fever in 2, CSF leak in 2, ventricular hemorrhage in 4, pioventriculitis in 3, infection of the surgical wound in 1, and extradural hematoma in 1. *Conclusions:* Hydrocephalus may be treated with different neuroendoscopical procedures, sometimes in combination. Therefore, each case should be considered exhaustively. Neuroendoscopy is a relatively safe and effective procedure associated with a steep learning curve.

4 Endoscopic third ventriculostomy in children under 2 years old: experience of a neuropediatric service in Brazil. J.A. da Costa Val, T.R. Noci, A. Lara, L.M. Herval, P. Serrano (Belo Horizonte)

Introduction: Endoscopic third ventriculostomy (ETV) offered a successful alternative to the management of obstructive hydrocephalus. The best results of this technique were described in patients older than 2 years old, although this age-dependent rate of success has been questioned in recent literature. To evaluate this, we made a retrospective analysis of the ETV procedures performed in children below the age of 2 years. *Materials and methods:* In a series of 238 patients who underwent a neuroendoscopic procedure, 53 children less than 2 years of age underwent ETV. This group was then analyzed according to the type and etiology of the hydrocephaly, the presence of previous shunting or infection, and the outcome after the procedure. *Results:* The global effectiveness of ETV in this group was 62.2%. The aqueductal stenosis group had 85.7% effectiveness. The Chiari II group had low efficacy, especially those patients below 6 months of age. Children with a previous shunt or ventricular infection also had a low success rate. Babies under 1 month age had 90% efficacy. *Conclusion:* We conclude that ETV is a useful procedure in patients less than 2 years of age. Our results also indicate that the etiology of the hydrocephalus is related to the effectiveness of the procedure, as well as the presence of infection or shunt prior to the ETV. Low age does not seem to interfere with efficacy.

5 Endoscopic aqueductoplasty in pediatric patients. Y. Ersahin (Izmir)

Objectives: Although endoscopic third ventriculostomy (E3V) has been increasingly used in the management of noncommunicating hydrocephalus and it is considered an effective and safe procedure, some of its complications are potentially overwhelming. Aqueductoplasty can be a good alternative to E3V in selected pa-

tients. *Materials and methods:* In 17 children, endoscopic aqueductoplasty was performed. The patients ranged in age from 2 weeks to 19 years and there were 9 girls and 10 boys. The burr hole was between 3 and 5 cm anterior to the coronal suture. Rigid neuroendoscopes and a 3-French Fogarty balloon catheter were used to perform aqueductoplasty. *Results:* Aqueductoplasty, aqueductoplasty+stenting, and aqueductoplasty+stenting+E3V were performed as a primary endoscopic procedure in 6, 3, and 4 patients respectively. E3V, aqueductoplasty+stenting+E3V, and aqueductoplasty+stenting were performed as a secondary endoscopic procedure in 3, 2, and 1 patients respectively. In one of those who underwent a secondary endoscopic surgery, and who had previously had E3V alone, aqueductoplasty+stenting+E3V were performed. All patients had aqueductal stenosis and 7 had been previously shunted. One of the patients presented with an isolated fourth ventricle. The overall success rate was 71%. Previous central nervous system infection was a negative prognostic factor. *Conclusions:* In infants and small children, aqueductoplasty alone was highly associated with re-stenosis. Stenting the aqueduct in addition to aqueductoplasty seems to be more effective.

6 Hydrocephalus grading system to predict outcome of third ventriculostomy. U. Kehler, J. Regelsberger, J. Gliemroth, M. Westphal (Hamburg)

Objective: An important factor in making a recommendation of VP shunt or third ventriculostomy (TVS) for the treatment of hydrocephalus is the prognosis of the surgical procedure. A simple, broadly applicable grading system is designed to predict the outcome of TVS and is evaluated with clinical data. *Methods:* The hydrocephalus is graded on the basis of the extent of downward bulging of the floor of the third ventricle (normal position=0; downward bulging up to 5 mm=1 point; >5 mm=2 points); the direct visualization of the CSF-pathway obstruction (no=0 or yes=1 point), and progression of clinical symptoms (no=1 point, yes=2 points). The sum determines the grade-resulting in five grades. In this proposed grading system, no indication for TVS was seen in grades 1 and 2 (cases with no downward bulging floor and/or with no direct visible obstruction). The grading was evaluated with a series of 72 TVS performed in hydrocephalus grades 3,4, and 5. The results of TVS were classified as either good=shunt independence or failed=shunt dependence. Statistical analysis was done using Fisher's exact test. *Results:* Grade 5 showed good outcome of TVS in 95% (shunt independence), Grade 4 in 58%, and Grade 3 in 40%. The difference is highly significant ($p<0.01$). *Conclusion:* Retrospective application of this grading scheme to a series of TVS has demonstrated its high correlation with the outcome. The application of this standardized grading system has a large potential in decision-making as to how to treat hydrocephalus (VP-shunt or TVS). Prospective evaluation is on the way.

7 Lumbar resistance to CSF outflow correlated to patency of the cranial subarachnoid space and clinical outcome of endoscopic third ventriculostomy in obstructive hydrocephalus. R.A. Azeddine, O. Amtoft, V.B. Løgager (Copenhagen)

Objectives: Our objective was to correlate the lumbar resistance to cerebrospinal fluid (CSF) outflow, LRout, to the size of the cranial subarachnoid space (SAS) and the clinical outcome of endoscopic third ventriculostomy (ETV) in obstructive hydrocephalus (OH). *Materials and methods:* Thirty-two consecutive adult patients (15 men and 17 women with a mean age of 46 years) who had OH possibly requiring treatment were subjected to a lumbar infusion test, and the size of the SAS was measured. An ETV was subsequently performed in 21 patients (11 patients with idiopathic aqueductal stenosis and 10 with various causes of OH). *Results:* A tendency towards higher LRout values was demonstrated in patients

with a diminished SAS (<2.0 mm, 16 cases) compared with patients with a normal sized SAS (14 cases). The difference was not statistically significant, however, the LRout values were widely scattered, and markedly increased values (>24 mm Hg/ml/min, $n=4$) were only demonstrated in the presence of a diminished SAS. Mean LRout (12.8 mm Hg/ml/min, CI 9.8–16.7) of the patients improving after ETV ($n=12$) was not significantly lower than the mean LRout (13.4 mm Hg/ml/min, CI 8.8–20.3) of the patients who did not improve ($n=9$). However, only low LRout values were found if the analysis was restricted to the subgroup of patients presenting idiopathic aqueductal stenosis, normal sized SAS, and improvement after ETV. **Conclusions:** In patients with idiopathic aqueductal stenosis, clinical improvement after ETV seems to be predicted by low LRout values, suggestive of a normal CSF absorption. However, patients with OH may likewise improve despite increased LRout, if the cranial SAS is diminished. In such cases the flow from the infusion test is impeded, resulting in falsely elevated LRout values.

8

Elastance correlates with outcome of endoscopic third ventriculostomy in adults with hydrocephalus due to primary aqueductal stenosis. L.M. Tisell, M. Edsbacke, H. Stephensen, M. Czosnyka, C. Wikkelsø (Göteborg, Cambridge)

Objective: Our objective was to study prospectively the correlation between the clinical outcome after endoscopic third ventriculostomy (ETV) and resistance to outflow of cerebrospinal fluid (Rout) and elastance in adults with hydrocephalus caused by primary aqueductal stenosis (AS). **Methods:** Rout and elastance were measured in the subarachnoidal space (SAS) and intraventricularly (IV) prior to ETV in 15 consecutive patients. Three months after the ETV, the clinical effect was evaluated by standardized indices and Rout and elastance were measured. If symptoms persisted and the ventriculostomy was patent, shunt surgery was offered. The effect of the shunt operation and Rout was measured after 3 months. **Results:** Four patients showed excellent improvement, 6 a slight improvement, and 5 were unchanged or deteriorated after ETV. The Rout before ETV did not correlate with the outcome. The Rout decreased after the ETV, with correlation to the clinical effect, and in the 6 patients subjected to shunt surgery the Rout decreased further. High preoperative elastance correlated strongly with a good outcome and reduction in ventricular size. The elastance did not change after ETV. **Conclusions:** Rout intraventricularly and in the SAS could not predict the outcome of the ETV but the reduction in Rout correlated positively with clinical improvement. Preoperative elastance correlated positively with clinical improvement and elastance was unchanged after ETV. Clinical improvement correlated positively with a reduction in ventricular size.

11 September Thursday: 12.30–13.30

Session III B: Free presentations

Complex hydrocephalus

9

Long-term efficacy of endoscopic choroid plexus coagulation in the treatment of neonatal post-hemorrhagic hydrocephalus. R.J. Edwards, I.K. Pople (Bristol)

Introduction: The use of endoscopic coagulation of the choroid plexus (CPC) to treat communicating hydrocephalus is extremely controversial. We report our experience of the technique in the management of posthemorrhagic hydrocephalus (PHH). **Methods:**

A retrospective review of all 40 infants who underwent CPC for PHH at our institution over a 30-year period was undertaken. Preoperatively, all infants had ventriculomegaly and a head circumference >98th centile or were dependent on regular ventricular taps to maintain head circumference <98th centile. The median gestational age was 29 weeks. Mean age at surgery was 3.7 months (range 3 weeks to 12 months). No follow-up was available for 1 patient. For the remainder the mean duration of follow-up was 13.7 years (range 2–27 years). **Results:** A total of 64 CPC operations were performed. Six patients underwent unilateral CPC and 34 patients bilateral CPC (staged in 21 out of 34). Eight procedures were abandoned due to xanthochromic CSF ($n=4$) and minor intraoperative bleeding ($n=4$) obscuring vision. Perioperative complications were as follows: drain displacement/CSF leak ($n=8$), ventriculitis ($n=3$), seizures ($n=2$), skin necrosis over reservoir ($n=1$), respiratory complications ($n=2$), and subdural hematoma ($n=1$). At the last follow-up, 12 patients (30%) remained shunt independent. In a further 15% of patients hydrocephalus was initially arrested but decompensated at a mean of 24 months (range 5–52 months) and they required a shunt. Shunt-independence was associated with an decreased risk of epilepsy ($p=0.03$). **Conclusions:** Endoscopic choroid plexus coagulation is of limited benefit in the management of PHH. Although arrest of hydrocephalus initially occurred in 45% of patients, only 30% achieved long-term control.

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Endoscopic management of isolated fourth ventricle in children. M.J. Fritsch, H.M. Mehdorn (Kiel)

Objectives: We report and discuss indications, surgical methods, and outcome results of 18 pediatric patients who underwent endoscopic aqueductoplasty or interventriculostomy (lateral or third ventricle to fourth ventricle) for the treatment of isolated fourth ventricle. We compare the results with those of patients who either underwent suboccipital microsurgical fenestration or fourth ventricle to peritoneum shunt for isolated fourth ventricle. **Materials and methods:** We retrospectively reviewed the medical histories and postsurgical outcome of 18 patients with isolated fourth ventricle. Surgical procedures included: endoscopic aqueductoplasty, endoscopic aqueductoplasty with stent, endoscopic interventriculostomy, endoscopic interventriculostomy with stent. The surgeries were performed between July 1996 and July 2002. Mean age of the patients at the time of surgery was 3 years. Mean follow-up was 28 months. **Results:** Clinical symptoms (impairment of consciousness, tetraparesis, ataxia) improved in all patients. Eight patients required reoperation due to restenosis. Six patients were treated with a stent and 2 patients underwent re-aqueductoplasty. We had the following complications: 1 infection/ventriculitis, and 1 permanent and 2 transient oculomotor paresis. **Conclusions:** The significant failure rate of fourth ventricle shunts has led to the development of alternative treatment methods. Endoscopic aqueductoplasty or interventriculostomy presents an effective, minimally invasive and safe procedure for the treatment of isolated fourth ventricle in pediatric patients. Compared with suboccipital craniotomy and microsurgical fenestration endoscopic aqueductoplasty is less invasive and compared with fourth ventricle shunts it is more reliable and effective.

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The role of endoscopic third ventriculostomy in the treatment of normal pressure hydrocephalus. M. Gangemi, F. Maiuri, G. Colella, S. Buonamassa, E. de Divitiis (Naples)

Objectives: Normal pressure hydrocephalus (NPH) can occur as the result of head injury, cranial surgery, hemorrhage, meningitis or tumor. Unfortunately the majority of NPH is from an unknown cause, making it difficult to diagnose and understand. Compounding this difficulty is the fact that the symptoms of hydrocephalus

are similar to the effects of the aging processes. Nevertheless, the usefulness of the surgical treatment, the indication for surgery, and the prognostic value of some tests are still debated. Intracranial pressure monitoring, infusion tests, and cisternography are currently the preoperative investigations that are used the most, although their prognostic value is unclear. *Materials and methods:* From 1993 to 2000 we treated 45 patients affected by NPH. According to particular radiological and clinical criteria 21 of these patients were selected for endoscopic treatment. Patients with posthemorrhagic hydrocephalus and SNC infections or tumors were not included in this series. *Results:* In 14 patients a clinical improvement was observed; in 4 patients preoperative symptomatology remained unchanged, while in only 2 cases a shunt placement was required due to a stomy failure. *Conclusions:* ETV can be used effectively to treat NPH. Nevertheless, careful patient selection has to be done according to clinical and radiological data.

12 Endoscopic third ventriculostomy in shunt malfunction and slit-ventricle syndrome. H. Mori, K. Nishiyama, R. Tanaka (Niigata)

Objectives: We have reported that CSF dynamics convert from a shunt-dependent state to a shunt-independent state within 1 week of endoscopic third ventriculostomy (ETV) for shunt-dependent non-communicating hydrocephalus (J Neurosurg 98:1027, 2003). We discuss our strategy for removal of long-standing shunts including slit ventricle syndrome (SVS). *Materials and methods:* Twenty-five patients received ETV for shunt malfunction or SVS between 1997 and 2002. All of them were 5 years or older. In those without SVS, an external ventricular drain (EVD) was installed after ETV with shunt-removal and the drain was set at 30 cm from the external auditory meatus (EAM). In SVS patients, the shunt catheter was externalized from the anterior chest and set at 10–15 cm from the EAM to dilate the lateral ventricles to the normal size. Then the ETV was performed and the newly set EVD was gradually raised in height. The daily amount of CSF drainage was checked and the EVD was removed when the daily amount decreased below 30 ml. *Results:* Twenty-two out of 25 (88.0%) shunted patients succeeded in having their shunt removed including 4 out of 5 myelomeningocele patients. Failed cases had a past history of bilateral subdural hematoma, disseminated tumors, or thick arachnoid adhesion in the prepontine cistern. *Conclusion:* Long-standing old shunt systems, even in patients with SVS, can be removed using the above-mentioned strategies except in those with factors of CSF absorption disturbance.

13 Endoscopic third ventriculostomy in the treatment of non-communicating hydrocephalus associated with Chiari I malformation: report of four consecutive cases. J. Osman-Farah, M. Javadpour, G. Quigley, P. May, N. Buxton, C. Mallucci (Liverpool)

Introduction: Chiari I malformation is a rare abnormality characterized by the caudal displacement of the cerebellar tonsils below the foramen magnum. *Purpose:* Non-communicating hydrocephalus is associated with a Chiari I malformation in a minority of cases. The objective of this study is to evaluate the role of endoscopic third ventriculostomy (ETV) in the management of symptomatic adult patients with hydrocephalus associated with Chiari I malformation. *Methods:* Between 1998 and 2003 four patients with hydrocephalus associated with Chiari I malformation underwent ETV. They constituted 1.6% of the 236 ETVs performed in the same time frame. All patients were evaluated with pre- and post-operative MRI and flow study. Follow-up ranged between 6 months and 2 years. *Patients:* There were 2 males and 2 females, the age range was between 22 and 70 years and the main symptoms were related to intracranial pressure, with 2 patients having

syringomyelia. Surgery was performed in all patients using a flexible endoscope. *Results:* There were no complications. ETV was successful in 3 patients with resolution of the clinical symptoms and radiological improvement on follow-up MRI. One patient experienced symptomatic progression of his hindbrain-related syndrome despite a patent ETV and required foramen magnum decompression (FMD). None of the patients needed cerebrospinal fluid (CSF) diversion by means of a shunting procedure. *Conclusion:* In our limited experience, ETV is safe and effective way of managing hydrocephalus associated with Chiari I malformation. In addition, hindbrain-related symptoms are often controlled. Progression of the hindbrain related syndrome despite the resolution of the hydrocephalus occurs in a minority of patients; these patients will require a FMD.

14 Fourth ventriculo-peritoneal shunt assisted by flexible neuroendoscopy in the setting of a trapped fourth ventricle and increased intracranial pressure. R. Rodríguez-DellaVecchia, J. Torres Corzo (San Luis Potosí)

Objective: A trapped fourth ventricle has become a challenge in the surgical management of patients with increased intracranial pressure (ICP), particularly with endoscopic correction. The purpose of the study is to investigate the reliability of fourth ventriculo-peritoneal shunt assisted by flexible neuroendoscopy as a resolutive measure for a trapped fourth ventricle and intracranial hypertensive symptoms. *Methods:* The study covered the period from January 1996 to June 2002. A total of 87 patients with a trapped fourth ventricle evaluated by neuroendoscopy were selected. All patients had had at least a CT scan of the brain prior to the surgical intervention. In all cases there was increased intracranial pressure. Follow-up of at least 12 months was provided. In all cases endoscopic treatment included canalization of the occluded aqueduct using an aqueductoplasty technique. In 11 cases a second procedure with the placement of a shunt in the fourth ventricle was evaluated in a subset of refractory patients in addition to the original therapeutic procedure. *Results:* Seventy-six patients had excellent resolution of the symptoms as well as evidence of improvement in the fourth ventricle obstruction after the endoscopic measure. Eleven patients who had a torpid evolution due to reinstatement of the increased ICP, were also diagnosed with mild or severe ependymitis. All of them required the placement of a fourth ventriculo-peritoneal shunt, and symptom resolution and regression of the fourth ventricle dilation were accomplished. *Conclusions:* The placement of a fourth ventricle shunt is a safe and effective measure for alleviating increased ICP when canalization of occluded aqueduct by flexible neuroendoscopy fails. Further studies with a large population are desirable.

15 Neuroendoscopic surgery in multiloculated hydrocephalus. P. Spennato, G. Cinalli, C. Ruggiero, F. Aliberti, V. Trischitta, G. Maggi (Naples)

Objective: The purpose of this study is to determine the safety and efficacy of neuroendoscopic treatment in patients with multiloculated hydrocephalus. *Methods:* Between September 1999 and December 2002, 36 endoscopic approaches had been performed in 22 patients with various forms of multiloculated hydrocephalus, including intraventricular septations (7 patients), isolated lateral ventricle (8 patients), both intraventricular septations and isolated lateral ventricle (2 patients), entrapped temporal horn (1 patient), and intraventricular septations associated with trapped fourth ventricle (4 patients). Different endoscopic procedures had been performed: fenestration of intraventricular septations, fenestration of the septum pellucidum, third ventriculostomy, aqueductoplasty by the rostral or caudal approach, and foraminal plasty of the foramen of Monro. In 9 cases the ventricular catheter of a ventriculo-peri-

toneal shunt had been placed under direct endoscopic control spanning the fenestration. The aim of surgery was to control hydrocephalus, simplify the shunt system, and reduce operative morbidity and mortality related to the high rate of mechanical shunt failure and shunt infection, typical of multiloculated hydrocephalus conventionally treated by multiple shunting. *Results:* The procedures were successful (control of hydrocephalus by a single shunt or no shunt) in 18 out of 22 patients. Fifteen patients needed a single endoscopic approach, 7 patients required repeat operations because of the appearance of new compartmentalizations or closure of the fenestration. In 12 patients who had had a shunt system implanted for at least 1 year prior to endoscopy the shunt revision rate decreased from 1.71 to 0.13 per year after endoscopic surgery (mean follow-up: 17 months). Ten children underwent endoscopic treatment until 1 year from the appearance of hydrocephalus. After endoscopy the shunt revision rate was 0.2 per year in this group, with a mean follow-up of 14 months. Surgical complications included 4 cases of CSF infection and 1 case of thalamic hematoma, which resulted in transient akinetic mutism, with full recovery. This patient died a sudden death 3 months after the operation. None of the patients had new neurological deficits related to the procedures. *Conclusion:* Endoscopic treatment is a safe and effective technique to control hydrocephalus in cases of multiloculated hydrocephalus. Because of its high versatility that permits different procedures such as fenestration of septum pellucidum and intraventricular septations, foraminoplasty, aqueductoplasty, and third ventriculostomy, the endoscopic approach should be considered as the initial treatment option. Indications for endoscopic surgery are the expansion of an isolated compartment and episodes of shunt malfunction or shunt infection in order to simplify the shunt system and remove infected hardware.

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The role of septostomy for endoscopic surgeries of the third ventricle. N. Zdenek, J. Chrastina, P. Krupa, I. Ríha, R. Jancalek (Brno)

Objective: During embryonic development the ventricular system of the brain divides into four compartments. Thalami and fornices with the thalamostriate vein border the paired foramina of Monro. In third ventricular expansions there is dilatation of these pathways and the third ventricular disturbance of CSF flow. The treatment is lesion removal and connection with basal cisterns. Modulation of pressure relations is the connection of the lateral ventricles to increase the pressure transmission. *Materials and methods:* Septostomy was performed on the third ventricle and intraoperative adverse cardiac events leading to asystolia were eliminated by diverting the pressure into the lateral ventricles. Contralateral ventricle ventriculostomy was feasible due to the septostomy. Our group of patients underwent 240 endoscopies, 120 of which were for hydrocephalus. In 17% of all patients septostomy was carried out, 17 of these for third ventricular lesions. *Results:* The benefit of septostomy is the perioperative reduction of the average pressure against the walls of the ventricles. It is the procedure of choice for univentricular hydrocephalus, if the contralateral foramen of Monro is free. Contralateral ventriculostomy is feasible. Septostomy is an artificial communication that mimics the physiological relationships of the ventricular system. When performed together with the endoscopic third ventriculostomy the treatment of triventricular hydrocephalus is possible without any risk of adverse pressure rise in the limited third ventricular space. The use of septostomy is advantageous in patients with haemorrhage and for dominant hemisphere lesions. *Conclusions:* Septum pellucidum is associated with congenital anomalies, e.g. cystis septi pellucidi, cavum vergae and veli interpositi. Frame-based navigation and virtual planning creates safety for surgery. Correct septostomy does not cause any risk to the patient or the operating surgeon. Patency verification is enabled by MRI flow sequences.

11 September, Thursday: 18.00–19.00

Session VII: Free presentations

Intraventricular lesions

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Endoscopic excision of colloid cysts: series of 29 cases. S.P. Chandra, A. Suri, V.S. Mehta (New Delhi)

Introduction: Twenty-nine patients with third ventricular colloid cysts underwent endoscopic excision from August 1999 to March 2003. *Material and methods:* Eighteen were males, and 11 were females. Clinical features included raised intracranial tension (ICT) symptoms in 24, diplopia in 8, drop attacks in 6, seizures in 1, and Hakim's triad in 1. CT scans were done in all patients and MR imaging in 22. A frontal burr hole or a small 2-cm trephine was performed. A rigid Gaab's (Karl's Storz) scope was used in all cases. The side of approach was mostly decided by imaging. The cyst wall was cauterized and the contents aspirated with a regulated suction. Following this cyst wall excision was performed using an indigenous two-port system. Complete excision was performed wherever possible. A simultaneous third ventriculostomy was performed in 14 cases and a septostomy if the septum was found not to be already perforated. *Results:* Total excision was performed in 20 cases and partial excision in 9 cases. This was confirmed by post-operative imaging in all cases. Complications included intra-operative bleeding in 2 (1 was controlled, the other underwent open craniotomy), meningitis in (1), and post-operative fever in (2). There was no mortality. Follow-up ranged from 2 months to 3.5 years. There has been no recurrence to date. *Conclusions:* The endoscopic excision of colloid cysts has been shown in our experience to be a safe, minimally invasive procedure, and a better alternative to open craniotomy.

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Postoperative third ventriculostomy in children with posterior cranial fossa tumors. G. Tamburrini, C. Di Rocco, M. Caldarelli, F. Di Rocco, G. Sabatino, M. Koutzoglou (Rome)

Introduction: The overall incidence of postoperative hydrocephalus requiring surgical treatment in cases of posterior fossa tumors in children ranges from around 25 to 30%. This incidence has been related to tumor histology, presence or absence of hydrocephalus at diagnosis, percentage of tumor resection, and the relationship between the lesion and the ventricular system, varying from 14% in children with cerebellar astrocytomas to about 45–50% in children with medulloblastomas and ependymomas. Sainte-Rose et al. proposed a protocol consisting of the preoperative endoscopic treatment of hydrocephalus in this kind of patients, in order to reduce intracranial pressure and achieve CSF samples for histological examination. Using this algorithm they referred to a reduction in postoperative hydrocephalus to 6%. The same authors, however, warn of the possibility that many of these children would not have needed a shunting procedure in any case. On these grounds, we developed a different algorithm in our Institution. An occipital ventricular catheter is positioned perioperatively and is left postoperatively for 5 to 7 days. During this period intracranial pressure (ICP) is monitored and a third ventriculostomy is performed only in patients with consistently abnormal ICP values. A ventriculo-peritoneal shunt is reserved for children not responding to endoscopic treatment. We report our preliminary experience using this protocol. *Methods:* From November 2000 to May 2003, 44 children (male to female ratio: 22:22) were treated for a posterior fossa tumor at the Pediatric Neurosurgical Unit of the Catholic University of Rome. Age at diagnosis ranged from 3 months to 16 years (mean age: 6.2 years). *Results:* Histological diagnosis was medulloblastoma in 15 patients, pilocytic astrocyto-

ma in 20 patients (13 cerebellar and 7 in the brainstem), ependymoma in 3 patients, ependymoblastoma in 2 patients, and fibrillary astrocytoma (brainstem), teratoid-rhabdoid tumor, choroid plexus papilloma, and ganglioglioma in 1 each of the remaining patients. Overall, 20 out of 44 of the children considered (45.4%) needed treatment for their postoperative hydrocephalus. In order to understand this relatively high rate of persisting hydrocephalus after tumor resection we compared this result with histological diagnosis, tumor location and its relationship with the fourth ventricle (tumor partially/totally inside or outside the fourth ventricle), presence or absence of preoperative hydrocephalus, and rate of tumor resection (total, subtotal, partial, biopsy). No significant difference was found in the comparison of tumor histology with persisting postoperative hydrocephalus. Nine out of the 24 children (37.5%) who underwent total tumor removal underwent a postoperative third ventriculostomy; a higher incidence was found in patients undergoing subtotal (5 out of 10, 50%) or partial (6 out of 9, 66.6%) resection. Thirty-five of the 44 tumors (79.5%) were partially or totally inside the fourth ventricle; 19 of these patients (54.2%) needed a postoperative third ventriculostomy. Only 1 of the remaining 9 patients (11.1%), all affected by tumors outside the fourth ventricle, needed treatment for the associated hydrocephalus. The most significant difference was found comparing children with and without preoperative hydrocephalus. All of the 20 postoperative third ventriculostomies were performed in children with hydrocephalus at diagnosis (20 out of 35, 57.1%). A limit of our algorithm was represented in this preliminary series by the rate of CSF infections, which occurred in the immediate postoperative period in 14 patients (14 out of 44, 31.8%); they were all easily treated using local antibiotic therapy, which did not influence the outcome. Five of these patients (5 out of 14, 37.5%) needed a V-P shunt; however, this rate has to be evaluated taking into consideration that the tumor was diffusely metastatic to the subarachnoid spaces at diagnosis in all patients. The only complication of the endoscopic procedure was represented by 1 case of hyperthermia, which spontaneously resolved after 8 weeks. **Conclusions:** The protocol proposed here should be considered as an alternative to that of Sainte-Rose et al., in that it allows adequate perioperative control of ICP, reduces the risks of occlusion of the ventriculostomy after tumor removal, and helps to select the patients who really need postoperative treatment of their hydrocephalus. Our preliminary results suggest that the neoplastic extension to the fourth ventricle and the presence or absence of preoperative hydrocephalus are the factors more significantly related to the need for a postoperative shunting procedure.

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Flexible neuroendoscopy in neurocysticercosis: hydrocephalus treatment and lesion removal. A developing country population-based study, outcomes and usefulness. J. Torres Corzo, R. Rodriguez Della Vecchia (San Luis Potosí)

Objective: Neurocysticercosis has become a health problem in developing countries particularly in Latin America. A well-known complication of the disease is the development of hydrocephalus due to obstruction of the ventricular system and basal arachnoiditis. To develop cost effective methods of treating this illness rather than conventional techniques, we evaluated the effectiveness of flexible neuroendoscopy. **Methods:** We selected a population of patients scheduled to undergo neuroendoscopy in the period between January 1996 and December 2002 at our institution. A total of 512 procedures were analyzed and 307 had neurocysticercosis. All patients had a brain CT and 81 patients had brain MRI. Follow-up ranged from 6 to 72 months. The surgical procedures performed were premamillary third ventriculostomy in 296 cases, cysticerci removal in 279, septum pellucidum fenestration in 138, foramina of Monro opening in 47, and opening and canalization of the aqueduct in 80 patients. **Results:** Two hundred and ninety-six patients underwent third ventriculostomy, 245 (82.7%) of them are

to date symptomatic, none of them required a ventriculo-peritoneal shunt procedure. Fifty-one (17.3%) of the studied population had as a complication increased intracranial pressure with recurrent hydrocephaly confirmed by CT; this subset of patients previously fulfilled the criteria for severe ependymitis. **Conclusions:** Third ventriculostomy with fenestration of the premamillary membrane and cysticerci removal is the procedure of choice for treating hydrocephalus associated with neurocysticercosis, it is cost effective and has low morbidity.

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Review of a personal series with special emphasis on the treatment of Rathke's cleft cyst and two complications. E.W. Hoving (Groningen)

Objectives: The indications of our personal series of 170 neuroendoscopic procedures were either obstructive hydrocephalus and/or fenestration of cysts. The overall outcome was successful in 127 patients (75%). Failure occurred in 37 (22%) while 6 (3%) patients were unchanged. A subdivision according to etiologies is presented: aqueductal stenosis, $n=56$ (43 successes, 13 failures); tumors, $n=36$ (32 successes, 4 failures); arachnoid cysts, $n=11$ (10 successes, 1 failure); and shunt dysfunction, $n=20$ (15 successes, 5 failures). **Materials and methods:** In 3 patients Rathke's cleft cysts were fenestrated using third ventriculostomy. No hydrocephalus was present in these patients. In 2 patients the cysts disappeared and the bitemporal hemianopsia resolved. In 1 patient the cyst recurred creating chiasmal compression. **Results:** Two serious complications occurred in this series. In 1 patient a steep rise in intracranial pressure took place perioperatively causing bilateral central retinal hemorrhages and central visual acuity was lost. A blood clot had blocked the outlet canal of the endoscope, while inadvertently rinsing the ventricle using a pressure bag. The other patient was successfully treated for his obstructive hydrocephalus caused by a low-grade astrocytoma of the thalamus. Although the postoperative MRI did not show a flow-void on the T2 sagittal plane, the patient's symptoms had disappeared. A few months later the patient deteriorated within several hours of a recurrent obstructive hydrocephalus resulting in near coning with irreversible damage to the brainstem. **Conclusions:** Neuroendoscopy offers us an effective and safe tool for the treatment of obstructive hydrocephalus and/or fenestration of cysts. Two serious complications caused by a sudden increase in intracranial pressure either perioperatively or during follow-up are illustrated.

21

Bilateral obstruction of the foramen of Monro. C. Mascari, U. Godano, A. Consales, F. Calbucci (Bologna)

Objectives: Obstruction of the foramen of Monro is an uncommon entity that may be caused by a wide range of lesions including tumors, vascular malformations, inflammatory conditions, and congenital atresia. The obstruction can be unilateral, resulting in a unilateral ventricle dilatation, or bilateral, causing a biventricular hydrocephalus. **Materials and methods:** We report on 3 adult patients, 2 males and 1 female, with symptoms of intracranial hypertension due to the presence of bilateral obstruction of the foramen of Monro. Neuroradiological examination showed bilateral ventricular dilatation with a relatively small third ventricle. **Results:** The surgical treatment consists of an endoscopic approach, which allowed the bilateral obstruction of the foramen of Monro to be verified (in 2 cases through a pre-existing septum pellucidum perforation and in 1 case through a septostomy), and to perform a reconstruction of the right foramen of Monro. The procedures were free of complications and all patients showed a postoperative improvement with resolution of clinical symptoms. **Conclusions:** Neuroendoscopic intervention is an alternative treatment in the management of hydrocephalus due to idiopathic obstruction of the foramen of Monro. The procedure is less invasive than open mi-

crossurgical reconstruction and can even avoid ventriculo-peritoneal or ventriculo-atrial shunting.

22

Endoscopic techniques in third ventricular expansive processes: report of 46 patients. G. Fernandez Molina, R. Jaimovich (Buenos Aires)

Objectives: We report 46 patients who presented third ventricular expansive processes treated using neuroendoscopic techniques. Clinical, radiological, surgical management, outcome, and histological findings are discussed. *Materials and methods:* Between August 1995 and June 2003, we treated 46 patients with third ventricular expansive pathology using endoscopic techniques. The average age was 22.40 years old (range 1 month–76 years). Twenty-six patients were female and 20 were male. *Result:* In all patients histological diagnosis was performed. The colloid cysts and one epidermoid cyst were totally resected. In the rest of the patients, partial resection or tumoral biopsy was performed. In most of the patients, third ventriculostomy was performed as a treatment for their hydrocephalus. Four patients with colloid cysts and 2 patients with a craniopharyngioma had postoperative transient memory deficit. Three patients had postoperative transient hemiparesis. There were no infection complications. Two patients died in the postoperative period from causes not related to the surgical procedure. *Conclusions:* Neuroendoscopic procedures are useful not only to make a histological diagnosis, but in some cases, tumor resection total or partial is possible. Third ventriculostomy is indicated in most cases of ventricular tumors to treat hydrocephalus. Neuroendoscopy is an effective method of diagnosing and treating third ventricular expansive lesions.

23

Endoscopic assisted Ommaya reservoir placement for treating cystic craniopharyngiomas. J. Roth, H. Ebran, N. Razon, Z. Ram (Tel Aviv)

Introduction: Cystic craniopharyngiomas tend to recur and thus removal of the entire lesion is the desired surgical goal. However, craniopharyngiomas seldom detach easily from the surrounding tissues and the surgical treatment may be limited. An Ommaya reservoir connected to a catheter placed in the cystic component has been suggested for two purposes: intratumoral treatment with bleomycin and as an access port for aspiration of the cystic component if it recurs. We present three examples of the endoscopic-assisted placement of the Ommaya catheter. *Methods:* Three patients with cystic craniopharyngiomas were treated with an intratumoral catheter that was placed with endoscopic assistance. One was situated in the third ventricle, a second in the interpeduncular cistern, and the third was adjacent to the midbrain. In the first two the cysts were approached through a right frontal craniotomy. In the third case, a right subfrontal approach was performed. In all cases the cysts were penetrated under endoscopic guidance and their contents partially evacuated, followed by placement of the catheter in the lumen. *Results:* In one case the cyst recurred and was thus aspirated and intracyst bleomycin injected via the Ommaya reservoir. The cyst has not recurred since. In another case, the size of the cysts remained unchanged and the patient improved clinically, thus no further treatment was indicated. In the third case – an intracystic bleeding occurred a few days after surgery, aspiration trials were unsuccessful even after 2 months and repositioning of the catheter. Eventually the patient underwent direct open surgical treatment. *Conclusions:* Endoscopic-assisted intratumoral placing of an Ommaya catheter in patients with cystic craniopharyngiomas may offer an easy and practical treatment for such lesions reducing the need for further surgery.

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Preoperative endoscopic treatment of hydrocephalus due to cystic craniopharyngioma. H. Dufour, S. Fuentes, P. Metellus, F. Grisoli (Marseille)

Objectives: Obstructive hydrocephalus due to the development of a craniopharyngioma often necessitates shunt implantation before surgical resection of the tumor. *Materials and methods:* We report 6 cases (2 recurrent cases) of cystic craniopharyngiomas. In these cases the first manifestation was an obstructive hydrocephalus. *Results:* All these tumors were mainly cystic and were first treated by transventricular endoscopic fenestration and evacuation of the cyst. In 3 cases this treatment led to the shrinkage of the cystic component and permitted a delayed intervention in better conditions without shunt implantation. In 2 cases of recurrent craniopharyngioma the puncture and fenestration of the cyst was sufficient to get clinical remission with a follow-up of 12 and 16 months respectively. In the remaining case a shunt was implanted despite a good prolapse of the cyst. Finally only this case had a definitive shunt. All but 2 patients were operated on between 2 months and 36 months after endoscopic evacuation of the cyst. In these 4 operated cases there were no abnormal adhesions due to the endoscopic procedure. *Conclusion:* Endoscopic fenestration and evacuation of a cystic component of a craniopharyngioma can be a good treatment for obstructive hydrocephalus, avoiding shunt implantation. In our cases this attitude does not compromise the efficacy of the microsurgical resection.

11 September, Thursday: 18.00–19.00

Session VIII: Free presentations

Neuroendoscopy and arachnoid cysts

25

The role of neuroendoscopy in the treatment of supratentorial midline arachnoid cysts. E. Schijman, G. Fernandez Molina (Buenos Aires)

Objectives: The objective of this presentation is to analyze the role of neuroendoscopy in the treatment of supratentorial midline arachnoid cysts. With this finality, the authors present technical aspects of the endoscopic procedures for the treatment of suprasellar and quadrigeminal cysts. *Materials and methods:* Intracranial arachnoid cysts are benign lesions, most of them of developmental origin, mainly located at the Sylvian fissure though, not infrequently, they may compromise the third ventricle region. The choice of the surgical options for the management of these lesions has been controversial. *Results:* The direct approach to the cysts by craniotomy is accompanied by a high rate of failure and is not free of complications. Shunting is associated with permanent shunt dependence, requires insertion of multiple catheters from the cyst and from the ventricles, and they may be technically difficult and present a high incidence of shunt malfunction with cyst and/or hydrocephalus recurrence. On the other hand, the vicinity of these lesions to the ventricular system makes them ideal for their endoscopic fenestration and communication with the CSF pathways.

26

Endoscopic neurosurgery for the treatment of nine intracranial arachnoid cysts. G. Talamonti, C. Solaini, G. D'Aliberti, M. Collice (Milan)

Objectives: Nine consecutive patients with intracranial arachnoid cysts were treated using purely endoscopic techniques („endoscopic neurosurgery“) at the Niguarda Ca' Granda Hospital of Milan, Italy, during the last 3 years. *Materials and methods:* There

were 5 males and 4 females. Ages ranged from 6 months to 24 years. Indication for treatment was based on: progressive non-localizing symptomatology in 3 patients, progressive cyst enlargement in 2 patients, hydrocephalus in 2 patients, intra-cyst hemorrhage in 1 patient, and space occupation in 1 patient. The cyst location was: sylvian in 3 patients, intra/para-ventricular in 3 patients, frontal in 1, interhemispheric in 1, and cerebellar in 1. In 3 patients there were multiple cysts. All patients underwent purely endoscopic treatment consisting of a single burr hole fashioned to access the cyst using a rigid operative endoscope via the shortest route possible. Using endoscopic instruments, the cyst wall was fenestrated as much as possible thus creating wide, free communication between the inside of the cyst and the ventricles and/or the basal cisterns. In 1 patient, stereotactic guidance was used to precisely target the arachnoid membrane in the angle between the internal carotid artery and the posterior communicating artery. **Results:** There was neither mortality nor major morbidity. Significant intraoperative hemorrhage occurred in just 1 case of a para-ventricular cyst. However, the bleeding was eventually controlled and there were no clinical consequences. Subcutaneous cerebrospinal fluid collection without true fistula was the late complication of the treatment of a sylvian cyst. No other complication was reported. Follow-up ranges from 3 to 36 months (mean 13 months). There was no postoperative deterioration. Seven patients clinically improved and two remained unchanged following initial improvement but had subsequent symptom recurrence. From a radiological point of view, 5 cysts decreased and 4 remained unchanged regardless of the clinical evolution. In 1 patient, the treated sylvian cyst was greatly reduced but a new large frontal cyst developed on the same site, which required further surgical treatment. **Conclusions:** This small experience confirms that purely endoscopic treatment ("endoscopic neurosurgery") may be considered in the management of intracranial arachnoid cysts. This treatment modality is very minimally invasive with a low complication rate. Its results are comparable with the results of other classic treatment modalities such as fenestration via open craniotomy or cyst derivation.

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Endoscopic surgery for pineal region tumors. S. Buonamassa, M. Gangemi, G. Colella, F. Maiuri, E. de Divitiis (Naples)

Objectives: The optimal treatment of tumors of the pineal region is controversial. The direct microsurgical approach implies several operative risks related to the deep location of the lesions, together with the presence of important neurovascular structures. In recent years, endoscopic surgery has gained a more important role. **Materials and methods:** We report our experience of 5 patients harboring pineal region neoplasms who were treated using the endoscopic technique. **Results:** In all cases, the procedure included third ventriculostomy for the correction of the hydrocephalus, a CSF sample for cytology, and tumor markers and a tumor biopsy for histological diagnosis. **Conclusions:** In a one-stage procedure, the endoscopic approach allows a CSF sample, tumor markers and a tumor biopsy to be obtained, as well as treatment of the hydrocephalus by third ventriculostomy.

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Endoscopic treatment of midline arachnoid cysts. J. Brown, P. Barlow (Glasgow)

Objectives: Our objectives were to compare results of endoscopic treatment of midline arachnoid cysts in two locations, the prepontine and the quadrigeminal cistern. **Methods:** A retrospective review of the clinical and radiographic records of 8 consecutive patients with prepontine and 8 consecutive patients with quadrigeminal cistern cysts was carried out. **Results:** Patients with prepontine cysts ranged in age from 3 months to 38 years. All had obstructive hydrocephalus caused by large arachnoid cysts that elevated the

floor of the third ventricle and obstructed both foramina of Monro. All were successfully treated endoscopically by wide cyst deroofing in a single procedure. None required a shunt postoperatively. The patients with quadrigeminal cistern cysts ranged in age from 3 months to 60 years. All had large arachnoid cysts compressing the aqueduct of Sylvius. Three patients were initially treated by endoscopic cyst fenestration. None of the cysts resolved or decreased significantly in size with endoscopic fenestration. Two have been re-explored endoscopically with no improvement and 1 of these went on to have an open procedure that was successful. Three others have been successfully treated with open cyst fenestration through a posterior fossa craniectomy and are shunt-independent. Two have been successfully treated with cystoperitoneal shunting and ventriculo-peritoneal shunting. There were 12 operations on the arachnoid cysts of these 8 patients and there is concern in 2 cases that further surgery may be required. **Conclusions:** Prepontine arachnoid cysts can be effectively treated by endoscopic fenestration. Arachnoid cysts in the quadrigeminal cistern are not effectively treated by endoscopic fenestration and require either an open procedure and wide cyst fenestration or cystoperitoneal shunting.

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Endoscopic treatment of intracranial arachnoid cysts. K. Karabatsou, M. Javadpour, C. Mallucci (Liverpool)

Aim: In this study we report our experience in the endoscopic management of intracranial arachnoid cysts. **Methods:** We retrospectively reviewed 24 patients with symptomatic arachnoid cysts who were treated endoscopically over a 5-year period. The median age of the patients was 5.5 years (range: 1 week to 68 years). There were 13 male and 11 female patients. The patients' symptoms included headaches, vomiting, seizures, endocrine disturbances and balance problems. The group consisted of 3 patients with hemispheric cysts, 5 with temporal/sylvian fissure cysts, 8 suprasellar cysts, 3 quadrigeminal cistern cysts, 2 posterior fossa cysts and 3 multiloculated arachnoid cysts. In 4 cases a shunt had previously been inserted. A flexible endoscope was used in most cases except for the sylvian fissure cysts. In the last 3 cases the neuronavigation system was also used. **Results:** The follow-up period was 6 to 36 months. All patients were assessed postoperatively with MRI and MRI flow studies. Twenty-one patients (87.5%) had complete or partial resolution of their presenting symptoms and only 3 (12.5%) experienced a progression of their symptoms requiring shunt insertion. The latter patients belonged to the neonatal group with multiloculated cysts. There was no mortality or morbidity. There was one case of minor bleeding which was easily controlled with irrigation. **Conclusions:** Endoscopy is recommended as the first line of management of arachnoid cysts that are located adjacent to the basal cisterns or the ventricles. The recent advent of neuronavigation coupled with endoscopy increases the safety and efficacy of the procedure.

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Neuroendoscopic techniques in the treatment of arachnoid cysts in children with regard to other operative methods. E. Nowoslawska, L. Polis, D. Kaniewska, W. Mikolajczyk, J. Krawczyk, W. Szymanski, K. Zakrzewski, J. Podciechowska (Lodz)

Objectives: The authors intended to evaluate the application of neuroendoscopic techniques for the treatment of arachnoid cysts in children in comparison with other operative methods. **The clinical material:** The analysis covered the results of the treatment of 42 children with arachnoid cysts who were subjected to neuroendoscopic procedures and 64 patients who underwent other operations. **Materials and methods:** The criteria of success varied according to the type of operative treatment. In the case of operative treatment other than shunt implantations, treatment was regarded as effective when there was no need to change the operative meth-

od. The lack of necessity of reoperation was a condition of an effective shunt implantation. The final results of operative treatment were assessed according to the Glasgow Outcome Scale. **Results:** Regarding the aforementioned criteria for success in the treatment of arachnoid cysts, neuroendoscopic procedures were one of the most effective methods apart from microsurgical cyst excisions. Cystocysternostomies or cystoventriculostomies were successful in 100% of cases. The analysis of clinical results showed that the deterioration was observed in only 13% of the patients treated by shunt implantations. Considering separately each type of arachnoid cyst, it was revealed that there was a statistically significant relationship between the state of improvement and the use of craniotomy in operative treatment for the cysts localized in the posterior fossa. Neuroendoscopic techniques allowed for a decrease in the average period of hospitalization. **Conclusions:** The effect of neuroendoscopic treatment depends on the quality of a connection between a lumen of the arachnoid cyst and CSF cisterns. The application of neuroendoscopic techniques allows for a reduction in the period of hospitalization.

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Neuroendoscopic approach in the hydrocephalus secondary to midline lesions: personal experience. S. Cipri, G. Gambardella (Reggio Calabria)

Patients and methods: The authors report, from a total of 112 neuroendoscopic procedures performed in the last 5 years, and with the aid of intraoperative videotapes, 14 cases of hydrocephalus secondary to midline lesions, using the neuroendoscopic approach. The mean age of the patients was 47 years (range 2–56 years), with a follow-up ranging from 3 months to 5 years after discharge. **Results:** In 6 patients the hydrocephalus was secondary to a lesion in the pineal region (1 tumor of the left thalamus, 4 tumors of the pineal gland, 1 cyst, and 1 amartoma of the tectal plate). In 2 cases hydrocephalus was associated with a suprasellar arachnoid cyst, and in 1 case each associated with an “entrapped fourth ventricle”, Arnold-Chiari type I associated with non-communicating thoracic syringomyelia, stenosis of the foramina of Magendie and Luschka, and recurrence of cerebellar medulloblastoma. Hydrocephalus was triventricular in 12 cases, biventricular in 1 case and tetraventricular in 1 case. Endoscopic third ventriculostomy (TVC) was performed in 4 cases, TVC plus biopsy of the pineal lesion in 3 cases, TVC plus aqueductal plasty in 1 case, TVC plus cystoventriculostomy in 2 cases, TVC plus endoscopic extratecal cerebrospinal fluid shunt catheter placement in 1 case. In 3 patients in whom a ventriculoperitoneal shunt system was implanted, a concomitant endoscopic biopsy of the lesion and two endoscopic ventricular catheter placements were performed. **Conclusion:** The Authors conclude presenting results, advantages, and limits of the endoscopic approach in hydrocephalus secondary to midline lesions, underlining that these neuroradiological tumors are remarkably dishomogeneous and of non-univocal preoperative interpretation.

12 September, Friday: 13.00–14.30

Session XI B

Lunch session – Video session

32

The role of neuroendoscopy in posterior fossa surgery. N. Zdenek, P. Krupa, J. Chrastina, I. Riha, R. Jancalek (Brno)

Objective: The development of endoscopy for the supratentorial ventricular system proceeded more rapidly than neuroendoscopy of the posterior fossa. This difference was caused by the larger ar-

ea of the supratentorial ventricular system. The compartments of the posterior fossa and fourth ventricle are much smaller spatial units. The floor of the fourth ventricle in particular, which is crowded with vital structures, does not allow more extensive surgery to be carried out. **Materials and methods:** In our group of neuroendoscopic surgeries there were 20 posterior fossa cases. Detailed presurgical planning together with virtual reality are integral parts of surgical intervention. Cystic expansions are especially amenable to neuroendoscopy. Tumorous lesions are indicated for endoscopic biopsy with subsequent conversion into open surgery when required. **Results:** The video presentations illustrate the possibility of surgical treatment of a haemangioblastoma located at the base of the cerebellar hemisphere. The second video shows the possibilities of a diagnostic biopsy of an inoperable tumour in the medullary and pontine area. The topic of the third presentation is the endoscopic treatment of a posterior fossa arachnoid cyst. Particularly in the phase of gaining experience, the use of frame-based navigation with the possibility of presurgical virtual planning bears utmost importance. The surgical procedure therefore becomes minimally invasive and safe. The patients can be mobilised early with the prospective of subsequent treatment. **Conclusions:** Neuroendoscopic surgery in the posterior cranial fossa is a safe method of diagnosis and treatment for neurosurgical patients

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Results of neuroendoscopic third ventriculostomy in hydrocephalus of various etiologic factors. R. Repac, L. Vujotic, N. Repac, D. Grujicic (Belgrade)

Objectives: Our objective was to evaluate the results of endoscopic third ventriculostomy in hydrocephalic patients according to etiology. **Materials and methods:** At the Institute for Neurosurgery Clinical Center of Belgrade, we have operated on 100 hydrocephalic patients over the past 3 years. The Aesculap Rigid Neuroendoscope, 6.8 mm was used, and in all cases neuroendoscopic third ventriculostomy (NTV) was performed using a balloon catheter 2–3F. We analyzed the patients by age, type of hydrocephalus, previous procedures performed, previous complications, and results of NTV. **Results:** Thirty percent of our patients were children and 70% adults, the most frequent type was obstructive hydrocephalus caused by aqueductal stenosis or tumor compression, but we have tried also with postmeningitis, posthemorrhagic, and even normotensive hydrocephalus. The best results we had were with the first group with 90% success, no complications, hospitalization ending 2 days after surgery, and no failure in the 10-month follow-up period. The poorest results we had were with normotensive hydrocephalus, which did not change in 70% of patients. We also treated colloid cysts and carried out parasital cyst extirpation from the third ventricle in one stage using NTV. **Conclusion:** With proper preoperative evaluation NTV is a superior procedure in comparison with classical CSF shunt operations in the treatment of obstructive hydrocephalus, with short, safe operation, high percentage of successes, and a minimal risk of complications. The procedure also reduces dramatically the costs of hospitalization, antibiotics, and CSF drainage units. In short, NTV has huge advantages over classical surgery in the treatment of hydrocephalic patients.

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The new devices for endoscopic endonasal transsphenoidal surgery. T. Kubota, K. Yoshida, T. Nakagawa, K. Sato (Fukui)

Objectives: We have performed endonasal microsurgical transsphenoidal surgery through a single nostril on 90 patients with pituitary region tumors since 1994. Recently, we operated on 18 consecutive patients via an endoscopic endonasal approach. The purpose of this study is to assess the new devices related to the surgical procedure. **Materials and methods:** In endoscopic endonasal surgery, we usually used special instruments such as Endo-

scrub irrigation system, various sizes of nasal speculum, rotating-type tools of Kerrison punch, microscalpel, ring-curette, and new hemostatic instruments as PAL-I and Arthrocare. Intraoperative 2D- and 3D-CT and VEP monitoring were used during the operation. **Results:** An irrigation system, Endoscrub, that is equipped with an endoscope, prevents the endoscopic lens from blurring with blood and nasal mucosa and provides a clear close-up view. Two-step use of the nasal speculum, from a small to a large size, afforded less traumatic procedure when opening a narrow nostril and nasal cavity. Rotating-type tools such as the Kerrison punch, microscalpel, and ring curette allowed the surgeon good control in a narrow operating space. New hemostatic instruments, intraoperative 2D- and 3D-CT, and VEP monitoring provided a safer operation in the pituitary region. **Conclusion:** Additional improvements such as upgrading tools, new technical developments in a narrow operating field will facilitate endoscopic surgical procedures.

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Endoscopic recanalization of aqueduct of Sylvius. P.A. Oppido, F. Cattani, E. Morace, E. Occhipinti (Rome)

Introduction: The aqueduct of Sylvius may be obstructed by congenital, inflammatory, or neoplastic lesions inside. On MRI or CT the diagnosis of aqueductal obstruction can generally be inferred by the finding of dilatation of the lateral and third ventricles, but the cause of obstruction cannot always be determined. In our experience endoscopic procedures are used either for the diagnosis of obstruction, or to remove the cause of aqueduct obstruction. **Materials and methods:** We present a case of fourth ventricle enlargement in a patient with an epidermoid cyst who was operated on 1 year ago. Drainage of the fourth ventricle cyst by catheter was unsuccessful. Third ventricle navigation by flexible endoscope was performed. The endoscopic procedure highlighted the aqueduct dilated and obstructed by old adherence due to blood clot organization. During the same procedure the aqueduct deobstructed and the third ventriculostomy was performed. **Results:** Endoscopic navigation of the fourth ventricle showed the presence of residual epidermoid tumor. On the follow-up there was a clear resolution of the cerebellar syndrome and restoration of CSF pathways.

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Neuroendoscopic approach in a cystic middle-line tumor with fast ICP increase. R. Mottaran, M. Mattana, G.B. Costella, D. Rossi, G. Salar (Padova)

Objectives: We report one case of a 23-year-old man. **Materials and methods:** He had been complaining of headache for 10 months, and had two epileptic seizures. MRI showed a nodular-cystic thalamic expansive lesion, with extension into middle part of the left lateral ventricle and a monolateral ventricular part-dilatation. The neurological picture was characterized by a rapid clinical worsening, for which we had to go immediately to the operating room. Our first aim was to obtain a decrease in ICP using a flexible neuroendoscopic approach to the occipital ventricle, for which we used a Frazier burr hole. **Results:** When we opened the posterior part of the lateral ventricle, we obtained a controlled deliquoration and then a good ICP decrease. In the same way, we opened the intraventricular tumor cyst using a neuroendoscope and Neo Dimion contact laser fiber device. Then we removed a part of this cystic lesion. The following histological examination diagnosed a neurocytoma. Postoperatively the patient has been very well. The use of the laser in the neuroendoscopic approach aids the neurosurgeon not to damage the vascular structures further. **Conclusion:** The benefits of this surgical approach were: the speed of surgical action, diagnostic and therapeutic action at the same time and in an emergency, a minimally invasive procedure and fast patient recovery, and planning for treatment after invasive surgical procedures.

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Utility of electromagnetic field system PAL-I with a ventriculofiberscope in neuroendoscopic surgery. K. Yoshida, T. Kubota (Fukui)

Purpose: An electromagnetic field system, PAL-I, was constructed at the Laboratory of Japan MDM, Inc. The system powers a neurosurgical device that generates a high frequency wave signal of 13.56 MHz to vaporize, cut, and coagulate tissue. The purpose of this study was to determine the usefulness and safety of the system when used together with a flexible ventriculoscope (ventriculofiberscope, Machida, Inc., Japan) in neuroendoscopic surgery. **Methods:** The PAL-I flexible ball electrode with a 1.4-mm tip diameter is inserted into the working channel (internal diameter 2.0 mm) of the ventriculofiberscope (outer diameter 4.8 mm). In the endoscopic treatment of pineal cysts, biopsy of intraventricular tumors, third ventriculostomy, and septostomy of the septum pellucidum, operative techniques such as vaporization, cutting, and coagulation are performed with the PAL-I, with 10–15 W power. **Result:** Firstly, compared with laser systems, the PAL-I energy is focused at the tip of the electrode, and is so accurate and pinpointed that it does not cause damage or thermal necrosis to the surrounding vital structures. Secondly, the device does not need a grounding pad and has no adverse effect on other electrical instruments in the operating room. Thirdly, the flexible ball electrode used with the ventriculofiberscope is easy to manipulate, allowing the surgeon full control without restricting movement in the operation. **Conclusion:** Using the PAL-I flexible ball electrode together with the ventriculofiberscope allows a precise operation and makes it possible to reduce duration of surgery. An example of the endoscopic treatment of a pineal cyst will be shown in the video.

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Pure and combined endoscopic approach in the surgical treatment of third ventricle tumors. M. Iacoangeli, M. Dobran, F. Rychlicki, M. Scerrati (Ancona)

Objectives: The trend in modern neurosurgery is toward minimally invasive surgery. Aiming at fulfilling this philosophy we started to use the endoscopic, transfrontal, transventricular, transforaminal approach (ETTT) to third ventricle tumors, both as pure procedure or in combination with a tailored skull base cranio-orbito-zygomatic approach (COZ) for the surgical treatment of third ventricle tumors or intra-third-ventricular cystic extension by parasellar craniopharyngiomas. The purpose of the study was to verify the feasibility of the method to safely remove the tumor in an acceptable surgical time shortening the hospital stay and patient discomfort. **Materials and methods:** Seven patients (aged from 4 to 67 years) were operated on last year. One had a teratoma, 3 had colloid cysts, which were treated using a purely ETTT approach (1 biportal), and 3 had intra-third-ventricular mushroom-like cystic extensions of parasellar craniopharyngiomas, which were approached using a combination of ETTT as first step to remove or release the cystic part and then a tailored COZ, with a different degree of orbitotomy and zygomectomy, to remove the solid part and eventually the residual collapsed cystic part. As operating tools we used a rigid endoscope and the usual scissors and forceps, implemented in the latter 3 cases using a contact laser device. **Results:** There was no mortality or major morbidity. One patient experienced transitory memory disturbances and another case developed hydrocephalus, which was treated by third ventriculostomy. In 6 cases resection was grossly total (1 colloid cyst required two operations, one on each side) and in 1 patient with a craniopharyngioma it was partial. Mean hospital stay for pure ETTT was 5 days and for the combined approach was 10 days. The mean time for the ETTT approach (pure or as first step of the combined one) was within 3.5 h. Because of the lack of dedicated and developed instruments endoscopic tumor removal was sometime tedious and time-consuming. **Conclusions:** Because of the possible strong ad-

hesions on the surrounding structures of the cystic sac, Yasargil proposed a combined approach (transcallosal and pterional) to treat craniopharyngiomas with a cystic, mushroom-like extension into the third ventricle. The ETTT approach seems to be the natural evolution of the transcallosal route, and the tailored COZ approach seems to be the logical evolution of the classical pterional approach. Both these surgical techniques imply the concept of "mini-invasive" surgery; the keyhole endoscopic approach by definition, but also the COZ approach maximizing bone removal, prevent excessive brain retraction resulting in a mini-invasive procedure on the brain parenchyma. Furthermore, providing a better angle of view, both frontal and temporal, toward the lamina terminalis and optic-carotid window allowed the complete removal of the solid part of the tumor as well as the shrunk, residual intraventricular cystic component pulled out from the bottom. When indicated, pure ETTT is the best reasonable option versus the microsurgical approach for intraventricular lesions. Based on the present encouraging experience is easy to foresee that future dedicated instruments, improved laser devices, and a miniaturized ultrasonic aspirator or water jet dissector will allow endoscopic procedures to be even more efficient, rapid, and safe in the near future.

39 Neuroendoscopic treatment of third ventricle arachnoid cyst. D. Grujicic, L. Vujotic, R. Repac, N. Repac (Belgrade)

Objectives: Primary arachnoid cysts occur in 1–5% of all intracranial expansive lesions, or rather, space-occupying processes intracranially located. Ten percent of them are supratentorial (mostly in the Sylvian fissure or the lamina quadrigemina region). A very rare cyst of the third ventricle grows from suprasellar region, compressing the floor of the third ventricle and expanding into the ventricle. As a final result there is cystic formation inside the third ventricle with compression of aqueductus and foramina of Monro, causing hydrocephalus. *Materials and methods:* These cysts are usually seen before the age of 5 and only 13 of all reported cases were older than 20. The usual clinical presentation is hydrocephalic in 80% of cases, combined with mental retardation, but compression of the visual pathways may also be seen, together with endocrine dysfunction (GH and ACTH deficiency, pubertatis praecox, etc.). The special sign "bobble-head doll" may be seen. *Results:* The typical CT presentation is the Mickey Mouse appearance of ventricles at coronal sections. The use of contrast enhancement could be useful. MRI produces the best visualization. Radical surgery is not possible in all cases and the recurrence rate is high. One of the suggested procedures (by Pierre-Kahn) is endoscopic fenestration. *Conclusions:* The ventricles may remain large, but with no signs of increased intraventricular pressure.

40 Casual removal of cysticercal cyst from the subarachnoid space after third ventriculostomy. R. González Rodríguez, C. Fernández Carballal, F.A. Gutierrez, R. Carrillo Yagüe (Madrid)

Introduction: Hydrocephalus is a common clinical feature in patients with neurocysticercosis. Endoscopic third ventriculostomy may be useful as reported previously. We report the findings observed during endoscopic third ventriculostomy in a patient diagnosed with neurocysticercosis and hydrocephalus. *Methods and results:* A 79-year-old woman born in Ecuador presented with chronic hydrocephalus. A MRI could not identify intraventricular or subarachnoidal cysts. Initial treatment consisted of a ventriculoperitoneal shunt, but malfunction was diagnosed and the system had to be removed. Neuroendoscopy was planned in order to perform a third ventriculostomy to avoid shunt malfunctions. Immediately after the fenestration of the premamillary space a cysticercal cyst suddenly erupted from the subarachnoidal space causing an obstruction of the ventriculostomy. The cysticercus was suc-

cessfully removed. The patient improved neurologically with radiological resolution of the size of the ventricles. *Conclusion:* Intraventricular cysts are not always present in patients with hydrocephalus secondary to neurocysticercosis. In the racemose form cysts appear in the basal arachnoidal spaces and produce intense inflammation. Inspection of the basal cisterns and profuse irrigation with saline is strongly recommended after the procedure to avoid further occlusion produced by the cysts.

41 Resolution of an acute, obstructive, triventricular hydrocephalus by endoscopic removal of a third ventricular haematoma without third ventriculostomy: case report. G. Barbagallo, R. Alessandrello, L. Manfrè, N. Francaviglia (Caltanissetta, Catania)

Objectives: Endoscopic treatment of intracerebral and/or intraventricular haematomas remains controversial and yet not very common due to technical difficulties encountered during the procedure. In cases of primary or secondary intraventricular haematomas leading to obstructive hydrocephalus, external CSF diversion procedures are most commonly used; however, risks of obstruction and/or infection are relevant. Endoscopic removal of the clots has been so far associated with third ventriculostomy. *Material and methods:* We report the case of a 42-year-old woman who sustained a left fronto-nuclear haemorrhage that ruptured into the lateral ventricle. *Results:* On admission she was alert and orientated (GCS 15), with a right-sided hemiparesis; no hydrocephalus was visible on CT. Three days later, a rapid and progressive neurological deterioration was observed and her GCS dropped to 10. An urgent CT scan demonstrated acute, triventricular hydrocephalus sustained by a blood clot in the third ventricle obstructing the aqueductus. However, the subarachnoid spaces were not involved by the haemorrhage nor were the lateral and fourth ventricles were full of blood. The patient, hence, underwent endoscopic removal of the third ventricular clot with clear restoration of the CSF flow through the aqueduct. Therefore, a third ventriculostomy was not felt to be necessary. For the sake of safety an EVD was positioned during the same procedure, but this never needed to be opened. A control CT scan the following day confirmed the complete removal of the clot with resolution of the hydrocephalus; this was coupled with a definite neurological improvement and on the second postoperative day the EVD was removed. Radiological and clinical follow-up was satisfactory. An MRI scan with CSF flow sequences, 6 months post-surgery, demonstrated a perfectly functioning aqueduct with no hydrocephalus. *Conclusions:* We submit that in selected cases the endoscopic management of intraventricular haemorrhage is safe and effective, and a third ventriculostomy is not always needed.

12 September, Friday: 11.00–13.00

Session XI A

Free presentations

42 Quantitative comparison between the heads-up-display and common monitor in endoscopic surgery. E. Marchese (Rome)

Introduction: The use of heads-up-display (HUD) in endoscopic neurosurgical procedures has previously been described in the literature. But there were no studies reporting an objective evaluation of HUD use. In this study, we developed an experimental model to assess the real impact of HUD on the performance of the endoscopic procedure. *Methods:* The purpose of the test was to pick up six small objects from six tiny cavities located on the bot-

tom of a closed box using a 0° rigid endoscope and biopsy forceps. An electrical plate surrounding the cavity's edges registered any contact with the endoscope or with the forceps. The test was consisted of three different parts: in the first the TV monitor was located in front of the subject (0°), in the second the monitor was angled at 45° and in the third a HUD (800×600 pixel resolution) was used. To assure the data were free of a "learning curve" bias, the three trials were sequenced randomly. *Results:* Thirty subjects participated in the test. The average duration of the test and number of errors made during the test were: HUD 194 s/6.06 errors; monitor at 0° 224 s/8.33 errors; monitor angled at 45° 234 s/8.46 errors. Statistically significant results ($p=0.016$ and $p=0.014$) were found matching both time and error data of the HUD with those of the monitor angled at 45°. *Conclusions:* The results obtained in this study, especially those regarding the use of HUD compared with a 45° angled monitor, confirm that HUD influences positively the performance of the endoscopic procedure.

43 **Endoneurosonography: scientific principles and clinical application.** K.D.M. Resch (Greifswald)

Objective: The step from microneurosurgery toward endoneurosurgery signified a step toward a minimally invasive technique, but at the same time decreased its safety, which limits its applicability. The goal of further development had therefore been to make neuro-endoscopy safer. The current concept of establishing a guidance system is carried out by MR or CT in near real-time at enormous financial cost and technical effort. The surgical benefit of this approach is still not clear. Another concept, therefore, was to equip the scope with a sono-guiding system. After laboratory work, a sono-catheter for trans-endoscopic imaging was applied for the first time in neurosurgery in a first series of 52 patients with a broad variety of lesions. *Material and methods:* A trans-endoscopic sono-catheter (Aloka Deutschland GmbH, Düsseldorf, Germany) with a diameter of 1.9 mm (6F) was used and introduced into the working canal of an endoscope. The image produced by the probe is a 360° scan ("brain radar") displayed on a monitor, on which some parameters can be varied to get the best view of different anatomical structures. *Results:* In 39 cases intraoperative imaging was the main reason for investigation and in 13 cases neuronavigation was the focus of interest. In 18 cases of tumor resection control, targeting a visualized remnant was necessary. ENS proved in this small series to make neuroendoscopy safer and easier by online and real-time imaging with high resolution. There are limitations and artifacts, which should reveal themselves in laboratory and clinical experience. *Conclusion:* Endoneurosonography, as it stands, is a technique that can contribute to the concept of minimally invasive techniques in neurosurgery, as this presentation describes.

44 **Robot-assisted endoscopic microneurosurgery.** P.Y.K. Hwang, C. Lo, T.T. Yeo (Singapore)

Objectives: We have developed a robotic arm for neurosurgery, based on the Hexapod. Preoperative data and imaging is obtained, and input into the robotic arm. *Materials and methods:* The arm is adapted to hold high-speed power drills, microinstruments, and endoscopes. *Results:* Preliminary studies with the robotic arm on artificial patient models and cadavers have shown that it is a useful surgical adjunct. Advantages include: availability of a 'third hand' to hold the endoscope and other instruments in an ultra steady fashion; ability of the robotic arm to move the instruments, endoscope, etc., according to the needs of the surgeon, without the surgeon having to stop the main operation to manipulate any holding device; robotic arm functioning as a surgical assistant, without the need for another human assistant; robotic arm performing part of the surgery, e.g., drilling the petrous temporal bone in an indi-

vidually tailored presigmoid 'keyhole' approach; robotic arm acting as a stereotactic guidance system to lead the endoscope and other instruments to the target area. *Conclusions:* We believe that robot-assisted endoscopic and microneurosurgery will be the major innovation for neurosurgery in the 21st century.

45 **Endoscopic transoral-transclival approach to the brainstem and surrounding cisternal space. Anatomic study.** O. de Divoitiis (Messina)

Objective: The purpose of this study was to review the endoscopic, anatomical features of the anterior brain stem and surrounding cisternal spaces as seen through a transoral transclival approach. *Methods:* Fifteen human cadaveric heads, obtained from 10 fresh adult cadavers and 5 formalin-fixed adult cadavers, were used in order to demonstrate both the feasibility of an endoscopic transoral transclival intradural approach and its potential exposure, and to describe the anatomic features of such a surgical approach. In order to determine the exact extension of a safe entry zone through the clivus 20 skull bases were used to obtain anatomic measurements. *Results:* The transoral approach was performed without maxillotomy or mandibulotomy, but using a limited clival opening. The insertion of the endoscope provided full visualization of the anterolateral brainstem and cisternal spaces around it. The distance of the clivus from the alveolar maxillary bone was 87 mm. The length of the exposed surface of clivus averaged 29 mm. The width of the clivus at its base, between the condyles, averaged 20 mm, 27 mm at the level of the pharyngeal tubercle and 21 mm at the level of the vomer. The distance between the two hypoglossal channels was 28 mm; the distance between the two jugular foramina was 41 mm; the minimal distance between the inferior petrous sinuses was 21 mm. *Conclusion:* The endoscopic transoral-transclival approach enables full access to the anterolateral brainstem and to the cisternal space around it. The use of the endoscope has the potential to reduce the need for wider skull base opening and its dangerous postoperative complications.

46 **Endoscope-assisted far-lateral transcondylar approach: cadaveric study.** N. Hayashi, S. Endo (Toyama)

Objectives: The far-lateral transcondylar approach was used in this cadaveric study in an attempt to evaluate the usefulness of endoscope-assisted microsurgery in the posterior fossa of the skull base. *Materials and methods:* The study was carried using four latex-injected, formalin-fixed cadaver heads. After initial examination of intradural structures under an operative microscope, a zero-degree 4-mm diameter solid-rod endoscope lens was introduced and guided into position under the direction of the operative microscope. Photographs of the regional anatomy were taken through this lens and through a 30-degree angled lens and compared with photographs of the anatomy taken through the microscope. *Results:* Clear close-up views of the dural portals and intracranial course of the cranial nerves were obtained using the microscope. The endoscope was introduced through three corridors enclosed with cranial nerves, providing the surgeon with panoramic views of the verte-brobasilar arteries and anterior brainstem surface. *Conclusions:* The endoscope can be guided through narrow corridors and placed immediately adjacent to a region of interest at the skull base. It enables the surgeon to look around blind corners and work behind structures that are hidden from microscopic view.

47 **Supraorbital endoscopic corpus callosotomy.** J.P. Blount, M.D. Smyth, R.S. Tubbs (Birmingham, Alabama)

Objectives: Despite optimal medical management approximately 30–40% of patients with seizures remain intractable. Corpus cal-

losotomy is a highly effective surgical procedure for epilepsy but has become less utilized due to morbidity that is largely attributable to the approach. *Materials and methods:* In part 1, 6 human cadaveric heads were secured in pins. A left midpupillary incision was made with medial retraction of the skin. A paramedian burr hole was made and a rigid endoscope inserted just lateral to the midline. The falx cerebri was followed until the genu of the corpus callosum was seen. The callosum was sectioned under endoscopic visualization. Brains were harvested and examined. In part 2, 5 male pigs were anesthetized and placed in the supine position with the head elevated 45°. After a 1-cm midline skin incision a 0.5-cm diameter hole was made. The rigid endoscope was inserted and advanced until the corpus callosum was visualized. The callosum was sectioned, animals euthanized, and brains examined. *Results:* In part 1, all cadaveric transections of the corpus callosum were easily performed without apparent injury to vascular structures. The supraorbital approach provided an adequate corridor to manipulate the angulation of the endoscope for complete visualization of the corpus callosum. In part 2, the corpus callosum was readily transected in all specimens without apparent vascular injury. Video clips and photographs will be presented. *Conclusions:* Endoscopic corpus callosotomy via a supraorbital approach is technically feasible and could offer an alternative approach that substantially reduces morbidity and hospitalization associated with conventional approaches.

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Endoscope-controlled removal of anterior skull-base meningiomas: report of three cases. E. Buono, E. Martino, E. Amoroso, G. Giugliano, M. Genovese (Nocera)

Objectives: The concept of “key-hole surgery” clearly stresses the need to perform less invasive surgery, at the same time having good surgical exposure and minimal or no brain manipulation. Employment of an endoscope in neurosurgery, using existing cavities or a narrow surgical path, allows the surgeon’s eye to get close to the lesion; an angled lens endoscope even allows the surgeon to see “behind the corner.” Technological advancement, on the other hand, through production of smaller and smaller rod lens endoscopes with excellent image quality, paves the way for further developments, making viable both surgery through an existing path (ventricles, nostril, paranasal sinuses) and new approaches in which the endoscope is the sole visualizing tool. *Materials and methods:* Our experience is in the latter field. It consists of three cases in which anterior skull base meningiomas were totally removed by way of endoscope-controlled surgery via a transciliar subfrontal approach. *Results:* The difficulties to face in adopting such a technique are essentially those of preserving integrity of the frontal branch of the facial nerve, as well as of approaching the frontal sinus in the medial aspect of craniotomy. Another problem is represented by the limited height of craniotomy obtainable through a small incision in the eyebrow. As for integrity of the frontal branch, its protection has been assured through knowledge of its skin landmark. Awareness of the size of the frontal sinus, on the other hand, has allowed either its by-passing or its intentional opening to be planned, in the latter case with a subsequent repair using usual techniques. A good height of the opening has been assured through variation of the retractor’s position during craniotomy. It is also worth mentioning that it is relevant to hold the head in a mild extension, as it causes a spontaneous retraction of the frontal lobe; furthermore, suction of CSF in the operative field allows a good brain relaxation, making a lumbar drain useless. *Conclusions:* Our patients experienced a very good recovery; this approach may therefore deserve further applications and developments.

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Endoscopic endonasal repair of large ethmoido-frontal meningoencephaloceles. M. Wager, K. Diore, J.M. Klossek, B. Bataille, F. Lapierre (Poitiers)

Objectives: Over the last few years, the endoscopic endonasal treatment of rhinorrhea has become the method of choice, but the treatment of meningoencephaloceles includes the management of sometimes large defects. The authors present a retrospective series of 5 patients harboring ethmoido-frontal meningoencephaloceles treated at their institution between 1997 and 2002. One was of post-traumatic origin, 3 were following endoscopic endonasal surgery, and 1 was spontaneous. Four patients presented with rhinorrhea. One was free of rhinorrhea but the meningoencephalocele increased on serial imaging studies. *Method:* All patients underwent computerized tomography and magnetic resonance imaging preoperative scans. In all cases an endoscopic approach allowed characterization of the fistula and repair of the defect. No fluorescein dye was necessary to demonstrate the leak intraoperatively. Repair was obtained in 4 cases by septal cartilaginous graft and in 1 case by conchal graft. Fibrin glue was added in 1 case. *Result:* Mean follow-up was 27 months (12–60 months). Follow-up included serial clinical examinations with endoscopic inspection using a rigid endoscope under local anesthesia. No recurring rhinorrhea and no postoperative complications were observed. *Conclusion:* Endoscopic endonasal repair of meningoencephaloceles is a safe and effective procedure allowing treatment of large ethmoido-frontal defects. It is minimally invasive compared with intracranial approaches and must be recommended as the method of choice for treatment of these patients.

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Endoscope-assisted and endoscope-controlled approaches for cranial nerve microsurgery in the cerebellopontine angle. U. Godano, C. Mascari, A. Fioravanti, F. Calbucci (Bologna)

Objectives: Endoscopy was first used in diseases of the cerebellopontine angle for anatomical and diagnostic explorations in the 1970s. During the 1990s, technological advances in endoscopic procedures led to the widespread diffusion of the technique, such as assistance in microsurgery, which was particularly useful in surgery of the cerebellopontine angle. *Materials and methods:* We describe our experience of endoscope-assisted microsurgery for the treatment of neurovascular conflicts and of endoscope-controlled microsurgery for trigeminal rhizotomy, in the cerebellopontine angle region. We treated 40 patients, 37 of whom underwent microdecompression for neurovascular conflicts (31 for trigeminal neuralgia and 6 for hemifacial spasm) and 3 were subjected to trigeminal rhizotomy for neuralgia in multiple sclerosis. *Results:* Endoscopic assistance optimized the microsurgical procedure enhancing the identification and definition of conflict, overcoming possible anatomical obstacles (dark corners), and lastly, improving control of prosthesis placement. *Conclusions:* The technique of endoscope-controlled microsurgery (video-surgery) in which the endoscope is used for viewing and the surgical maneuvers are conducted with microsurgical instruments inserted alongside the endoscope, allowed a minimally invasive and safe approach for trigeminal rhizotomy.

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Endoscopic transsphenoidal approach to the sella. C.E. Deo Pujari, N. Shah (Mumbai)

Objectives: Our objectives were to evaluate the use of endoscope-assisted and image guidance in transsphenoidal surgery. *Materials and methods:* Endoscope-assisted microsurgery was the technique used in 192 cases over the last 5 years. The image guidance technique was used for microadenomas and recurrent pituitary tumours. One hundred and forty-seven patients were treated by the

first author using the endoscopic approach over the last 8 years. Ease of approach, completeness of excision, visual, haemorrhagic and nasal complication, postoperative recovery and hospital stay were all considered in order to evaluate the outcome. **Result:** Satisfactory removal of the tumour was achieved in all cases without vascular injury. Two patients later needed transcranial surgery, because of the very firm consistency of the tumour. One patient had postoperative apoplexy. Two patients had a CSF leak that required re-exploration. The average hospital stay was 4–5 days. **Conclusion:** The endoscopic approach to transsphenoidal surgery is an extension of the classical approach facilitating entry into corners of the sella and into the suprasellar compartments. This has not only facilitated more complete tumour removal, it also ensures safety by avoiding injury and reducing postoperative complications such as intratumoral haemorrhage. The nasal complications are virtually eliminated by the endonasal technique. Our experience of 192 cases operated on using this approach over a period of 5 years is presented to illustrate the technical variations that have allowed us to obtain good results with very low morbidity and a short hospital stay.

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Preliminary endocrinological results of endoscopic resection of 18 pituitary adenomas. H. Dufour, P. Dessi, T. Brue, P. Jaquet, F. Grisoli (Marseille)

Objectives: Since 1993 some authors have emphasized the possibility of curing pituitary adenomas endoscopically (De devitiis, Capabianca, Jho, Sethi). Just one team published hormonal results based on criteria admitted by the endocrine community (Capabianca et al.). **Materials and methods:** Since 2002, the authors (HD) began to operate on pituitary adenomas via the nasal route with a rigid endoscope. Eighteen selected cases were operated on. Criteria for selection were: apparently enclosed adenoma, well-pneumatized sphenoidal sinus, microprolactinoma ($n=2$), GH secreting adenoma ($n=5$), and nonfunctioning adenoma (NF) ($n=11$). Corticotrophic adenomas were operated on via the classical transsphenoidal approach and are presently excluded from the endoscopic technique. **Results:** The two microprolactinoma were cured (clinical remission with postoperative serum prolactin level <2.5 ng/ml and normally reactive to the TRH test). Six out of the 7 GH secreting adenomas were cured (postoperative mean GH level <2.5 ng/ml, normal Igf1 for age and sex and nadir of GH <1 ng/ml 2 h after oral administration of glucose). Nine out of 11 NF adenomas had no residual tumor on MRI 4 months after surgery. **Conclusion:** These preliminary results demonstrate that endoscopic treatment can lead to comparable postoperative results obtained with a microsurgical technique in selected cases at the beginning of an endoscopic experience. Our first impression is that the main advantage of endoscopy is that it allows a better view of the sellar floor, a wider opening of it, a better view of the intrasellar limits (diaphragma sellae and wall of the cavernous sinus), and probably a better resection of macroadenomas. Lower discomfort for the patient and shorter hospitalization time is, for us, at the present time, of little interest in this disease.

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Black' fiber tip: the key to low-power laser-assisted neuroendoscopy. W.P. Vandertop (Amsterdam)

Background: Most neurosurgeons are reluctant to use lasers in neuroendoscopic procedures because of fear of uncontrolled damage to neural and vascular structures. We have shown, in vitro as well as in vivo, that this fear is founded because when high-power laser light is used with uncoated fiber tips, superficial ablation does not even occur at 20 W for 10 s ($=200$ J) whereas significant thermal effects and tissue damage will occur in deeper structures. The use of specially coated, 'black' fiber tips, however, provides superficial ablation with low-power energy in

the range of 0.7–4 J per burst, causing virtually no effect in deeper tissues. **Methods:** Between November 1993 and July 2003, 171 neuroendoscopic procedures were performed using a specially developed laser catheter with an atraumatic ball-shaped fiber tip, pretreated with a layer of carbon particles. In 78 of these procedures the exact amount of energy used could be traced from the patients' records. **Results:** The majority of procedures (81%) were a third ventriculo-cisternostomy. The remaining 15 procedures were for colloid cysts ($n=7$) and ventricular cysts ($n=8$). A wide and patent opening of the floor of the third ventricle and wide fenestration of the cyst walls was performed in all cases using a Neuroview 2.3-mm flexible endoscope and an 400- μ m laser fiber through the 1-mm working channel using a 810-nm diode laser. The median energy per procedure was 112 J (range 3–1,751) for the entire group, 97 J (range 3–1,055) for ETVs, and 344 and 354 J for colloid cysts and ventricular cysts respectively. **Conclusion:** Using pretreated 'black' fiber tips, low-power laser-assisted neuroendoscopy is very effective and extremely safe at energy levels that are useless and harmless if uncoated fiber tips are used.

12 September, Friday: 16.15–17.00

Session XIII

Poster presentations

54

Abnormal and severe distortion of the third ventricular anatomy during endoscopic third ventriculostomy in previously shunted patients: a worrisome intraoperative experience. Case reports and review of the literature. G. Barbagallo, C. Schonauer, L. Manfrè, R. Alessandrello, F. Barone, M. Fricia, M. Maiello, M. Giuffrida, N. Francaviglia (Catania)

Objectives: Several complications of endoscopic third ventriculostomy (ETV) have been described, but little has been reported on the complications of ETV in previously shunted patients for long-standing hydrocephalus. **Materials and methods:** We describe three cases of ETV in patients in whom an acute and severe distortion of the third ventricle occurred before the fenestration was performed. **Results:** Patient 1, a 17-year-old girl, born premature and with a previously placed ventriculo-peritoneal shunt, presented with a 8-month-history of headaches, ideomotor slowing and progressively worsening urinary incontinence. Neuroimaging revealed a tetraventricular hydrocephalus and partial aqueduct stenosis. Patients 2 and 3, both already shunted for triventricular hydrocephalus secondary to quadrigeminal plate lesions, presented with histories of acute onset of headaches, vomiting, and visual blurring. Investigations confirmed a recurrent triventricular hydrocephalus. All patients underwent ETV successfully, but before opening the stoma a severe distortion of the third ventricular anatomy occurred. By altering the anatomical landmarks and increasing the surgeon's visualization, this event could have turned a simple and straightforward procedure into a risky and complicated one. Previously shunted patients with a history of long-standing hydrocephalus would seem to be a subgroup prone to presenting such a phenomenon. On preoperative MRI the downward displacement of the third ventricular floor is not necessarily a sign or a consequence of raised intracranial pressure. **Conclusions:** The role of CSF motion-sensitive MRI should be evaluated as a further preoperative adjunct. Pathophysiological causes underlying such a complication before performing the ventriculostomy are analyzed, intraoperative management to safely carry out the procedure is discussed, and the relevant literature is reviewed.

55
Endoscopic treatment of encysted fourth ventricle: two case reports. P. Barlow, J. Brown (Glasgow)

Objectives: Encysted fourth ventricle, sometimes called trapped fourth ventricle, isolated fourth ventricle, or double compartment syndrome, has been recognized as a difficult shunt-related problem for many years. Treatment by open operation or by shunting is notoriously prone to failure and to a high incidence of complications. *Materials and methods:* We present two patients with symptomatic encysted fourth ventricle following insertion of a ventriculo-peritoneal shunt. In the first case, postoperative adhesions (from excision of an astrocytoma in the posterior fossa) led to blockage of both the aqueduct and the fourth ventricle outlet foramina. The second case was related to severe intracranial infection. MRI scanning demonstrated decompressed lateral and third ventricles, with a grossly enlarged fourth ventricle. Both patients had become moribund prior to drainage of the fourth ventricle. *Results:* Endoscopic fenestration of the membrane blocking the aqueduct led to sustained improvement in both patients. In the first patient a third ventriculostomy was also carried out, resulting in shunt independence and a full recovery. In the second patient a lateral ventriculo-peritoneal shunt was required. Neither patient has required any further treatment to the fourth ventricle.

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Anatomical findings in ETV: frequency, intraoperative morbidity and MRI findings related. A. Bellotti, C. Iaccarino, A. Rapanà, E. Tedeschi, M. Schönauer (Caserta)

Objectives: Many anatomical anomalies have the potential to impair the efficacy of endoscopic third ventriculostomy (ETV) and increase surgical morbidity. Therefore, the objectives of the present study are to evaluate the frequency of endoscopic anatomic anomalies of the ventricular system, to define their potential to complicate the procedure and to compromise the surgical results, and to investigate the value of preoperative magnetic resonance (MR) imaging for their detection. This report could make a contribution to enabling the neurosurgeon to weigh the operative risk in a patient with an anatomic anomaly against the chance of performing ETV successfully. *Materials and methods:* The video recordings, the operative reports, and the preoperative MR images of 25 ETVs were reviewed, mismatching the intraoperative and neuro-radiological findings. *Results:* The clinical results with the most frequent anatomical variants were distance between the infundibular recess and the tip of the basilar artery (BA) on midsagittal magnetic resonance, size and diameter of the interventricular foramen, latero-lateral diameter of the third ventricle, atrophy of the corpus callosum, split of the fornical bodies, narrow retroclival space; prominent basilar tip, opaque and thick/atypically declining third ventricular floor, and a particular combination with an anatomical configuration of hydrocephalus, extreme dilatation of the third ventricle, disappearance of the interpeduncular cistern due to a very thin, membranous floor of the third ventricle, which herniated downward, draping over the basilar artery, possibly suggesting the upward ballooning of the third ventricular floor occurring immediately after perforation of the floor and withdrawal of a Fogarty catheter. The floor herniated into the third ventricle, hindering the endoscopic view.

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Endoscope-assisted transsphenoidal surgery: experience with 72 patients. G.V. Ciubotaru, L. Tataranu (Bucharest)

Objectives: The interest shown by neurosurgeons in using endoscopy in transsphenoidal surgery has increased. This study reports our experience using a rigid Storz endoscope in conjunction with the operating microscope during the second part of the sublabial-transseptal approach for lesions in the sellar and suprasellar re-

gions. *Methods:* Between 1 March 2000 and 1 March 2003, 72 patients (42 females and 30 males), with a median age of 39 years (range 20–65 years) were operated on at the Neurosurgical Clinic of the “Bagdasar–Arseni” Clinical Hospital using this method. The histological diagnoses included 58 pituitary adenomas, 9 craniopharyngiomas, 2 Rathke’s cleft cysts, 1 cerebrospinal fluid fistula, and 2 metastatic adenocarcinomas. Among the 58 patients with pituitary adenomas, 9 patients had microadenomas (15.5%), 16 had intrasellar macroadenomas (27.6%), 19 had macroadenomas with suprasellar extension (32.7%), and 14 had invasive macroadenomas involving the cavernous sinus with suprasellar extension (24.1%). *Results:* Of the 69 patients with mass lesions, 49 underwent total resection (71.0%) and 20 subtotal resection (28.9%), leaving residual tumor in the suprasellar region or in the cavernous sinus. In all cases we found the endoscope to be a useful tool particularly in large tumors with suprasellar and parasellar extension, where a residual tumor in the suprasellar or cavernous sinuses cannot be directly seen with the microscope. This residual tumor can then be identified and removed under endoscopic guidance. Also, the excellent visualization helps to avoid neurovascular injury. *Conclusions:* Endoscope-assisted microsurgery improves access and visibility within the confines of the sellar and suprasellar regions, thus reducing the inevitable surgical trauma. Two distinct advantages that an endoscope has over an operating microscope are its abilities to visualize through a narrow corridor and to provide angled, close-up views.

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Endoscopic fenestration of a bitemporal septated refractory ventriculitis: case report and overview of the literature*. A. Cordoba (Montevideo) *with the collaboration of the Neurosurgical Clinic of the Allgemeines Krankenhaus of Vienna, AKH, Vienna, Austria

Introduction: Postoperative septated ventriculitis continuous is a potentially lethal infection in many cases, with poor results when surgical and conventional methods are employed. Neuroendoscopic procedures may eventually contribute to improving the outcome, especially in severely injured patients, as a minimally invasive technique. *Materials and methods:* We present the case of a 38-year-old woman with a severe subarachnoid haemorrhage and a refractory bitemporal septated postoperative ventriculitis who was successfully treated with a neuroendoscopic fenestration. This is the first application of neuroendoscopy by Uruguayan neurosurgeons. *Results:* The neuroendoscopic fenestration as a minimally invasive technique contributed to improving the ventriculitis and the outcome of our patient. We concluded that this technique is a useful and safe procedure compared with craniotomy, especially in severely injured and low-grade patients. To our knowledge, this is the first report of the use of neuroendoscopic treatment in bitemporal refractory ventriculitis after a severe subarachnoid haemorrhage.

59
Mini craniotomy for neuroendoscopic third ventriculostomy in babies: technical note. J.A. da Costa Val (Belo Horizonte)

Objective: CSF fistula, subgaleal collections, and a pulsing frontal hole are complications after a conventional approach for the neuroendoscopic third ventriculostomy in babies less than 1 year old. We developed a new technique that allows us to avoid those complications, using the anterior fontanel and restoring the anatomy at the end of the procedure. *Materials and methods:* Based in the anterior fontanel, a right frontal mini craniotomy is easily done, allowing access to the lateral ventricle. After neuroendoscopy, the dura mater is closed, the bone flap returns to its place, and the wound is closed. *Results:* In the 21 children subjected to the technique, no more fistulas and subgaleal collections were detected. The esthetic aspect was also approved for the families. *Conclu-*

sions: Using the mini craniotomy the pediatric neurosurgeons could achieve a fast, easy, and safe approach to third ventriculostomy in babies, avoiding the main complications of this age.

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Endoscopic approach to the treatment of colloid cysts. W. Findlay, F. Tomlinson, P. D'Urso, D.G. Walker (Brisbane)

Objectives: Colloid cysts are benign tumours, which, when symptomatic, require surgery. There has been an increasing trend in neurosurgery towards incorporating minimally invasive approaches. We report 6 cases of endoscopic resection. *Materials and methods:* A retrospective analysis of 7 cases treated between 1997 and 2003 was performed. A rigid endoscope was utilised via a third ventriculostomy approach. Two cases used stereotaxy and another an antero-lateral port. All procedures required continuous high-flow, low-pressure irrigation with drainage via the endoscope or ventricular catheter. One case was converted to an open procedure due to the posterior cyst location limiting access. Third ventriculostomy was performed in 5 cases with insertion of a ventricular reservoir in 4 cases, an external ventricular catheter in 1 case and pellucidotomy in 1 case. *Results:* All patients were male (19–74 years of age, mean 45 years). Four presented acutely with severe headaches, 1 unconscious, 1 with drop attacks and the other with progressive memory loss. The unconscious patient was brain dead at 3 days. Follow-up to 5 years was carried out. There was radiological evidence of recurrence in 1 patient who underwent endoscopic re-excision of the cyst. Four patients returned to the workforce and 2 returned to pre-morbid functional level. *Discussion:* Endoscopic resection of colloid cysts is a safe and effective treatment. This procedure requires familiarisation with endoscopic techniques, endoscopic third ventriculostomy and intraventricular anatomy. Visualisation should be optimised with quality endoscopic cameras/monitors and with the use of low-pressure, high-flow irrigation. Endoscopic techniques may advance with the incorporation of frameless stereotaxis, and the development of instrumentation, pressure monitoring and irrigation systems.

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Endoscopic aqueductoplasty in children: technique, indication, and results. M.J. Fritsch, H.M. Mehdorn (Kiel)

Objectives: Endoscopic aqueductoplasty has been established as one option for the treatment of aqueductal stenosis. We describe our surgical technique, indications, and results in 24 patients who underwent endoscopic aqueductoplasty. *Materials and methods:* We retrospectively analyzed the treatment and outcome of 24 patients who underwent endoscopic aqueductoplasty with or without stent for the treatment of aqueductal stenosis. Surgeries were performed between November 1998 and December 2002. Mean age at time of surgery was 8 years and 8 months (range 4 months–16 years). Mean follow-up is 24 months (range 5–56 months). *Results:* We divided the patients in three groups. Group 1 consisted of 4 patients with membranous distal aqueductal stenosis. Three out of 4 were sufficiently treated by aqueductoplasty alone, and we saw 1 asymptomatic restenosis. Group 2 comprised 2 patients with aqueductal stenosis due to tectal tumor. The patients underwent aqueductoplasty and tumor biopsy with subsequent restenosis of the aqueduct. Group 3 consisted of 18 patients with isolated fourth ventricle. Twelve patients were operated on primarily with aqueductoplasty alone. Six patients underwent primarily a successful stenting procedure. We had the following complications: 1 infection/ventriculitis, and 2 transient and 1 permanent oculomotor paresis. *Conclusions:* In patients with a membranous distal aqueductal stenosis and ampullar widening of the proximal aqueduct aqueductoplasty alone will suffice. In patients with isolated fourth ventricle and a history of intraventricular hemorrhage and/or meningitis the risk of requiring restenosis is high. Therefore, we now favor primary stent placement. In pa-

tients with tumor-associated aqueductal stenosis aqueductoplasty alone will not stay open. Those patients would be better treated with third ventriculostomy.

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Evacuation of basal ganglionic intracerebral hematoma with image-guided neuroendoscopy using neuronavigation. T.-K. Lee, M.-C. Kim, S.-S. Jeun, C.-K. Park, K.-S. Lee, Y.-K. Hong, J.-K. Kang (Seoul)

Objectives, materials, and methods: The authors present the intra-axial application in the basal ganglionic hematoma of two patients of a neuronavigation system to adapt the rigid endoscope. *Results:* The neuroendoscope was introduced into the intracerebral hematoma through a frameless stereotaxic system with neuronavigation (Leibinger, Stryker, USA). The hematoma was then removed by continuous irrigation and suction under direct video visualization. The intracerebral hematoma was also cleansed by gentle, direct endoscopic irrigation and suction. The postoperative clinical course was uneventful. *Conclusion:* The neuronavigation system can be used selectively in the intracranial hematoma-associated cavity. The surgeon can choose the entry point, the target, and the optimal trajectory with image-guided neuroendoscopy with neuronavigation.

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Diagnostic value of CSF flow MR imaging in patients with neuroendoscopic third ventriculostomy by the use of differently acquired retro FISP 2D CINE MR studies. M. Nagulic, R. Repac, A. Milojevic, D. Kozic, K. Koprivsek, D. Djilas-Ivanovic, I. Vukadinovic, A. Repac, M.A. Lucic (Belgrade)

Objectives: Our objective was to determine the diagnostic value of two differently acquired CINE MR studies in visualization of pulsatile CSF flow intensity in patients with neuroendoscopic ventriculostomy (NTV) of the third ventricle performed for nontumorous aqueductal stenosis. *Methods:* In the period 1992–2002, 119 hydrocephalic patients underwent NTV by rigid endoscope (6 months to 71 years). In 41 patients with aqueductal stenosis we performed brain MRI on 1.5-T MR using differently acquired retro FISP 2D CINE studio before and after the NTV. Two ECG retro-gated FISP2D sequences (first one TR40/FA17 and second one TR30/FA70) at one fixed slice position in the mid-sagittal and paratransverse plane (last one located perpendicularly to the third ventricle floor) were displayed by multiple gated images in a closed-loop cine format. *Results:* Back-and-forth CSF flow through the perforation of the ventricle floor was observed with both RETRO FISP2D sequences in the mid-sagittal plane in 37 out of 41 patients (90.24%), but flow in the paratransverse plane was visible only by use of the RETRO FISP2D (TR30, FA70) sequence. Postoperative volume reduction of the ventricles was detected in 11 out of 37 (29.73%). No significant changes in the preoperative volume of the ventricles were found in 26 out of 37 (70.27%). In 4 out of 41 (9.76%) patients CSF flow was not detected by the use of both sequences in both planes, indicating a non-adequate postoperative effect. *Conclusion:* Both RETRO FISP2D (TR40/FA17) and RETRO FISP2D (TR30, FA70) sequences performed in the mid-sagittal plane may be used for the evaluation of CSF flow in patients who underwent NTV. Higher flow sensitivity was achieved on RETRO FISP2D (TR30, FA70) sequence in the paratransverse plane. In 41 out of 45 (90.24%) patients operated on using NTV, these MR sequences revealed patent communication.

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Endoscopic ventricular fenestration and ETV for the treatment of multicompartamental neonatal hydrocephalus. J. Osman-Farah, M. Javadpour, N. Buxton, P. May, C. Mallucci (Liverpool)

Introduction: Multicompartamental hydrocephalus is a rare form of neonatal hydrocephalus thought to be secondary to an intrauterine

insult. Conventional treatment by means of shunting is generally disappointing. Endoscopic treatment of multicompartimental hydrocephalus with fenestration and endoscopic third ventriculostomy (ETV) is an attractive alternative to shunting, even in very young patients. **Objective:** The objective of this study is to review the role of neuroendoscopy in the management of neonatal multicompartimental hydrocephalus. **Methods:** Between 1998 and 2003 three consecutive patients with congenital multicompartimental hydrocephalus underwent neuroendoscopic treatment by means of multiple fenestration and ETV. This constituted 1.2% of the 250 neuroendoscopic procedures performed in the same time frame. All three patients were male, the age at the time of the procedure ranged between 4 weeks and 1 year. All patients had symptomatic primary hydrocephalus. Radiological evaluation included pre- and post-operative MRI/flow study. The follow-up period ranged from 1 to 2 years. Surgery was performed using a flexible endoscope along with light touch balloon and ME2 electrode. **Results:** Neuroendoscopy was successful in 2 patients, with clinical and radiological improvement of the hydrocephalus. One patient experienced early failure of the endoscopic procedure requiring VP shunt insertion. One of the patients had minor venous haemorrhage during the procedure, but no other complications were experienced. **Conclusion:** Neuroendoscopy appears to be the ideal treatment for multicompartimental hydrocephalus. Fenestrations in the septae can establish communication between the loculi and the main ventricular cavities and ETV provides CSF flow into the subarachnoid space. In our experience neuroendoscopy is safe and effective in the management of multicompartimental hydrocephalus, having the advantage of avoiding shunt-related complications.

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Third ventriculostomy versus ventriculo-peritoneal shunt in obstructive hydrocephalus: the Lausanne experience. S. de Ribaupierre, L. Regli, B. Rilliet, O. Vernet, J.G. Villemure (Lausanne)

Introduction: Based on the concept that "no shunt is better than the best shunt," endoscopic third ventriculostomy (ETV) has become a routine procedure for obstructive hydrocephalus and tends to replace ventriculo-peritoneal shunts (VPS). To verify this concept we compared the revision-free interval of the two procedures. **Methods:** From January 1992 to December 2002, 60 patients underwent ETV (pediatric: 16, adult: 44) and 36 underwent VPS (pediatric: 17, adult: 19). All were treated for obstructive hydrocephalus at the University Hospital of Lausanne. The number of revisions and the revision-free interval were assessed. **Results:** There were 16 out of 60 revisions for ETV and 12 out of 36 for VPS. The mean number of revisions is 1 for ETV and 2.08 for VPS ($p=0.056$). The difference in revision-free intervals is not significant ($p=0.6$) with 14.4 months for ETV (pediatric: 27.8, adult: 8.3) and 20 for VPS (pediatric: 31.6, adult: 8.6). The percentage of revision at 6 months was: ETV 15%, VPS 11%; at 2 years: ETV 22%, VPS 28%; and at 5 years ETV 25%, VPS 31% ($p=0.11$). **Conclusion:** The overall failure rate is within the range in the literature (8–47%). The number of revisions and the revision-free interval are not significantly different between ETV and VPS. However, there is a trend in long-term follow-up for fewer revisions and a longer revision-free time in ETV patients. We therefore advise keeping ventriculostomy as the treatment of choice in obstructive hydrocephalus.

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Neuroendoscopic third ventriculostomy and intraventricular hemorrhage in preterm infants: is acquired aqueductal stenosis a reality? D. Scavarda, N. Bednarek, A. Paz Paredes, G. Lena (La Timone)

Object: The object of this study was to point out the delayed occurrence of aqueductal stenosis in preterm infants who have suffered

from intraventricular hemorrhage (IVH) and to try to explain the mechanisms of this stenosis. **Method:** From January 1996 to June 2002, 1,046 premature infants were admitted to our institution. Thirty-six neonates suffered from grade 3 or 4 intraventricular hemorrhage (Papile grading), of whom 16 died. Twenty patients survived and a ventriculoperitoneal shunt insertion was placed in 7 infants. Two patients underwent a neuroendoscopic third ventriculostomy (NTV). Follow-up was carried out twice a month during the first 2 months and subsequently twice a year. **Discussion:** Aqueductal stenosis must happen later after IVH in premature infants. This long delay may be explained by our hypothesis that stenosis is related to intraventricular and aqueductal inflammatory reactions and fibrous scars. These reactions are supported by a cytokine (TGF β 1), which is involved in scar and fibrous reactions. NTV is in our opinion the optimal treatment for such a condition. Late occurrence of such an obstructive hydrocephalus may partly explain the success of NTV where shunts have failed. **Conclusion:** NTV was an effective treatment for post-IVH hydrocephalus with an average follow-up of 29 months. The specific pattern in these patients is the long delay before the onset of obstructive hydrocephalus and the visualization of de novo obstruction with MRI. A biological explanation must be investigated.

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Incidental neuroendoscopic diagnosis of large communicating artery aneurysm. C. Schönauer, G. Barbagallo, S. Abet, A. Franco, C. Parlato, A. Moraci (Naples)

Objectives: The aim of this paper is to report an unusual observation during endoscopic third ventriculostomy (ETV). **Materials and methods:** We report a 81-year-old woman who, because of a likely syncope, fell down backwards and sustained a scalp injury. She was known to suffer from dementia and to be under the care of a neurologist; however, she had never undergone brain CT. **Results:** On admission, she was lethargic (GCS 9) and vomited several times in the emergency room. Urgent CT ruled out traumatic lesions but showed markedly dilated ventricles. In the suprasellar area a round, hypodense lesion with calcifications in the upper slices was seen. The patient rapidly worsened to a GCS of 5. A diagnosis of acute hydrocephalus was made and she was prepared for emergency ETV. A right, precoronary burr hole was drilled and a rigid endoscope was inserted into the right frontal horn. As soon as a dilated foramen of Monro was past and the third ventricle entered, a very large, ovoid, yellowish, and pulsatile lesion stemming from the antero-infundibular area was observed. The optic chiasma appeared to be stretched upwards. The ETV was carried out easily, although the ventricular floor diameters were narrowed by the pulsatile mass. A large anterior communicating artery (AcoA) aneurysm was diagnosed. Postoperatively the patient showed a prompt improvement and was able to walk and talk. MRI on the 7th postoperative day with angio-sequences confirmed the presence of the aneurysm with axial diameters of 1.2 cm and sagittal diameters of 1.6 cm. On the 9th day she was discharged home with a GOS of 5. In view of the absence of rupture or related neurological deficits and of the patient's age, no treatment was undertaken for the partially thrombosed AcoA aneurysm. **Conclusions:** The association between hydrocephalus and dementia in cases of giant AcoA aneurysms has been reported. Ishihara published a case of basilar tip aneurysm diagnosed during ETV but, to our knowledge, this is the first reported case of an AcoA aneurysm observed during ETV.

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Proposal for an adequate classification of complications following treatment of hydrocephalus. C. Sprung, W. R. Lanksch (Berlin)

Objective: Discrepant clinical results after treatment of hydrocephalus reported in the literature are not only due to deviating surgical

skills or the choice of valve, but also to significant differences in the definition of complications. *Methods:* By analysing diverging incidences of complications in the literature in comparison to our own experience, we want to stress the necessity of generally accepted, uniform definitions for evaluating the clinical outcome of hydrocephalic patients. The difficulties in defining unequivocal criteria for the judgement of complications are elucidated by comparing important reports of shunt series in the literature and the evaluation of 202 consecutive patients treated with the gravitational dual-switch-valve in our department. *Results:* Following a new algorithm, we primarily divided the complications into surgical insufficiencies, endoscopy- or valve-related difficulties and problems independent of the function of the device. A clear-cut differentiation of hygroma from simple widening of the subarachnoid space is mandatory. As a prerequisite for the evaluation of underdrainage, all explanted valves in our series had to undergo a specific bench test. The variety of the incidences reported in literature of the most important complications, over- and underdrainage, indicates the importance of an unequivocal definition of these entities and especially of the distinction between obstruction and functional underdrainage. As another factor, we want to stress the necessity of agreement on whether the different types of complications should be related to the total number of patients in the series, to all the complications or to mechanical complications only. *Conclusion:* Despite the fact that in some cases it is nearly impossible, all efforts should be made to differentiate mechanical complications from others. Otherwise a comparison of the results of endoscopic ventriculostomy with shunts or collectives using different valves will remain unattainable.

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Application of endoscopic surgery in the treatment of spontaneous intracerebral haematomas. K. Stachura, R. Czepko, W. Libionka (Cracow)

Objective: Evacuation of spontaneous intracerebral hematomas (SIH) by means of open surgery usually widens primary brain damage. Stereotactic surgery is blind until CT is performed after the procedure. We present our experience with a third possibility for treatment: the endoscopic evacuation (EE) of SIH. *Methods:* Twenty-three patients were included in the study. Fourteen out of 23 patients underwent DSA or MRA. Before endoscopy, the following criteria were considered: consciousness and/or neurological deterioration, haematoma volume bigger than 20 ml and midline shift more than 5 mm. SIH were located in hemispheres and in some cases extended to the basal ganglia. By means of the Storz neuroendoscope SIH were evacuated by fractionated rinsing and by suction. Bigger clots were fragmented but those adhering to the cavity wall were left behind. The outflow of clear Ringer fluid was a sign to finish the operation. Postoperative assessment of the SIH evacuation was based on CT. *Results:* Symptoms of brain oedema resolved in all patients. The significant trend towards reducing focal neurological deficits was observed: 16 patients improved, while 3 remained unchanged, and 4 finally deteriorated and died. The operation allowed for complete haematoma evacuation in 6 patients and diminishing of its volume in 17 patients. *Conclusions:* EE seems to be a useful alternative tool for SIH evacuation offering minimal invasiveness in comparison with open surgery. The advantages of EE over stereotactic evacuation are the visual control and use of tools like forceps and bipolar coagulation.

70

Treatment of arachnoid cysts – our experiences. T. Svoboda, K. Máca, P. Fadrus (Brno)

Objectives: Arachnoid cyst are rare – their reported incidence is only 1% of intracranial space-occupying lesions. Surgical treatment is reserved only for symptomatic lesions. In our institution

an endoscopic approach is preferred. *Materials and methods:* Thirteen patients (8 female and 5 male) with symptomatic arachnoid cyst underwent surgical treatment in our institution over the last 4 years: endoscopic procedures alone in 5 cases, open surgery in 4 cases, primary implantation of a V-P shunt in 1 case, a cysto-cisternal shunt in 1 case, and 2 patients were operated on endoscopically, but implantation of a V-P shunt followed. *Results and conclusion:* A successful result was reached in 77% (10 patients); 3 transient complications without serious morbidity were observed.

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Disproportionately large fourth ventricle treated using neuroendoscopic third and fourth ventriculostomy during neonatal period in a premature baby with intraventricular hemorrhage. K. Takahashi, H. Nakazaki, M. Yoshino, Y. Nonaka, S. Oi (Tokyo)

Objective: Despite recent advances in neuroendoscopy, hydrocephalus in patients under 6 months old or caused by intraventricular hemorrhage in infancy remains a controversial indication for neuroendoscopic third ventriculostomy. Furthermore, effective endoscopic treatment of disproportionately large fourth ventricle (DLFV) has not been reported. *Materials and methods:* We report a case of DLFV treated using neuroendoscopic third and fourth ventriculostomy during the neonatal period in a premature baby with intraventricular hemorrhage. The patient was a 3-month-old girl, first offspring of a 32-year-old GPO mother with myoma uteri at 22 weeks of gestation due to a ruptured uterus. The patient was born at extremely low body weight and experienced ventricular hemorrhage on the 2nd day after birth. Ultrasonic tomography demonstrated gradual dilation of the entire ventricular system to the level of severe hydrocephalus with increased cranial circumference. A miniature Ommaya's reservoir was placed, with daily aspiration of cerebrospinal fluid (CSF). At 3 months old, the patient underwent neuroendoscopic third and fourth ventriculostomy. *Results:* Postoperatively, hydrocephalus was arrested and cranial circumference stabilized without further aspiration of CSF for 3 weeks. However, hydrocephalus recurred, and repeated aspiration of CSF was again required. One month after neuroendoscopic surgery, a ventriculo-peritoneal shunt was placed. After the shunt operation, all ventricles normalized without further aspiration of CSF. *Conclusion:* This is the first report of neuroendoscopic third and fourth ventriculostomy applied in the treatment of DLFV occurring during the neonatal period. Third and fourth ventriculostomy is more physiological than other procedures, and might reduce the incidence of complications such as isolated fourth ventricle after shunting of the lateral ventricle.

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Endoscope assisted microsurgical removal of lateral ventricle epidermoid cyst: case report. E. Tessitore, A.R. Dehdashti, B. Rilliet (Geneva)

Introduction: Intracranial epidermoid cysts account for 1% of all intracranial tumors. They are usually located in the midline or in the paramedian regions (cerebello-pontine angle, parasellar region, middle cerebral fossa). They are intraventricular in about 15% of cases. Lateral ventricle epidermoid cysts are rare, accounting for 5% of all intracranial epidermoid lesions. *Case report:* The authors report a case of a giant lateral ventricle epidermoid cyst in a 42-year-old patient suffering from gait disturbances, mental depression, and memory deficits. The tumor was reached by means of a right-sided transcallosal approach. Macroscopic appearance was typical of an epidermoid cyst. The microsurgical removal was achieved using aspiration and rongeurs. A rigid endoscope was used to identify tumoral remnants in the postero-lateral portion of the ventricles that had been removed using the microsurgical technique. The left and right lateral ventricles, and the third ventricle have been carefully inspected using the endoscope. The tumor removal was incomplete because of the tight adherences between

the tumor capsule and the left postero-lateral ventricle ependyma. The postoperative outcome was uneventful with recovery of some of the preoperative deficits. The patient is still now under clinical and radiological follow-up, with no progression of the tumor's remnant. **Conclusion:** Total removal of a giant intraventricular lesion is a challenge for neurosurgeons. Epidermoid cysts may tightly adhere to the ventricle ependyma. A larger and more complete removal can be achieved using the neuroendoscope, which allows tumor remnants that cannot be exposed by the microsurgical traditional technique to be identified.

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Fatal status epilepticus following third ventriculostomy. F. Van Calenbergh, G. Kesteloot, W. Van Paesschen (Leuven)

Introduction: Patients with hydrocephalus frequently have seizures. However, the relationship between the occurrence of seizures and the treatment of hydrocephalus, either with a shunt or ventriculostomy, remains unclear. **Case report:** We treated a 77-year-old man presenting with a normal pressure hydrocephalus syndrome due to aqueductal stenosis, who had never experienced seizures, with endoscopic third ventriculostomy through a right coronal burr hole. The procedure was uneventful. After surgery, a focal epileptic seizure was noted in the left arm. The patient was treated with valproic acid and improved. The next day, consciousness deteriorated and EEG showed nonconvulsive status epilepticus. CT and MRI studies were normal and external drainage showed normal intracranial pressure. The epilepsy was very refractory, requiring artificial ventilation and sedation. Finally, the patient died of pneumonia. Autopsy did not show any lesions except the aqueductal stenosis. **Discussion:** Two studies by Kramer and Svendsen did not demonstrate an increased risk of epilepsy following endoscopic third ventriculostomy in a paediatric population. In our experience the risk is not high either, but a nonconvulsive status epilepticus carries a high risk of morbidity and mortality. No evidence exists as to whether prophylactic anti-epileptic drugs are useful in craniotomy patients. **Conclusion:** Endoscopic third ventriculostomy, like all cranial procedures, carries a risk of the induction of seizures, although it appears to be small. It is not known whether the prophylactic administration of anti-epileptic drugs lowers this risk. Detailed observation of the patient in the hours following surgery to detect early seizure activity seems to be warranted.

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Neuroendoscopic treatment of intraventricular cysticercosis. L. Vujotic, R. Repac, M. Kantardzic, A. Repac (Belgrade)

Objectives: Neurocysticercosis (*Taenia solium* and *Taenia saginata*), transferred by the blood stream, is found in the form of cystic larvae in the brain parenchyma, meninges, or ventricular system. The disease is seen in acute and delayed forms. Clinical presentation of the cysticercosis depends on the number and location of cysts, as well as on the phase of their evolution. Cysticercus in brain parenchyma, usually in the gray matter or subependyma, surrounded by perifocal edema, are recognized by MRI or CT. Meningeal cysticercosis is hard to diagnose by neuroradiological methods. Floating cysts in liquor are almost impossible to recognize, for they are moving along with liquor pulsation, thus causing paroxysmal obstructive internal hydrocephalus. MRI can reveal more voluminous cysts. **Methods and results:** We report a case with intraventricular cysticercosis well diagnosed by MRI and successfully treated using a neuroendoscopic procedure. **Conclusion:** We would like to stress the very low risk of dissemination after fenestration and extraction of a cyst located intraventricularly that has been mentioned previously by other authors.

12 September, Friday: 17.00–17.50

Session XIV A

Free presentations: Spinal neuroendoscopy

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The neurosurgical evolution of percutaneous spinal endoscopy. What is possible? T. Luebbbers, G. Sandvoß (Meppen)

Introduction: Minimally invasive techniques in spine surgery have progressed rapidly, giving the surgeon endoscopic tools that improve his ability to treat spinal disorders. **Method:** The Yeung Endoscopic Spine Surgery System (YESS) is used with a posterolateral approach after a small skin incision. Any herniation that is contiguous with the disc space and that has not migrated is appropriate for endoscopic fragmentectomy. **Discussion:** Compared with open techniques for the treatment of far lateral disc herniation this system is able to decrease the tremendous duration of the procedure and approach-associated morbidity. After removal of the herniated lateral fragment a clear visualisation of the affected exiting nerve root is possible. The system is set up to incorporate delivery of other intradiscal therapeutic measures such as laser, radiofrequency technology, and electrothermal energy. Due to the fact that collagenised herniations are often configured like an iceberg and the larger portion of the herniation is usually still contained within the disc, the procedure is advantageous for the surgical treatment of recurrent disc herniation. The potential for injury to the nerve root is always present, which is the reason why we use intraoperative EMG monitoring or a navigation system to avoid this complication in our general anaesthetic patients. Infections of the disc can be treated successfully with the YESS, even on the thoracic spine after endoscopic removal of the inflammatory debris, irrigation and antibiotic chain placement.

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Minimally invasive endoscopic placement of odontoid screws. F. La Marca, D. Karahalios (Ann Arbor)

Objectives: An endoscopic surgical technique was developed to facilitate the placement of C2 odontoid screws for the treatment of type 2 odontoid fractures. **Methods:** The Fluoronav image guidance system was used for preoperative and intraoperative planning. Under image guidance the odontoid screw was placed through a channel composed of a cylindrical MED type retractor and direct endoscopic visualization. Screw placement was verified postoperatively with cervical reconstructive CT scans. **Results:** Screw placement was obtained and verified to be as planned in all cases. In comparison with standard bi-planar fluoroscopic techniques of screw placement, operative time was not significantly increased, radiation exposure to the patient and surgeon was significantly reduced and risk of operative field contamination in patients with barreled thorax was also found to be significantly reduced. **Conclusion:** Minimally invasive endoscopic odontoid screw placement is an easy and useful technique that decreases contamination risk and radiation exposure, and facilitates preoperative planning along with intraoperative screw placement.

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Anterior cervical endoscopic discectomy – results of 100 cases. S. Schiffer, S. Ewers (Fremont)

Objective: The purpose of this study was to evaluate the outcome of anterior endoscopic discectomy for the treatment of cervical disc herniations. **Methods:** One hundred patients, presenting with radiculopathy and/or myelopathy, who underwent fluoroscopically-guided decompressive anterior cervical endoscopic discectomy at one or more levels between March 1996 and June 2001, were

asked to rate their neck and arm pain on the Visual Analogue Scale from zero to ten both before and after surgery. The neck disability index (NDI) was used to measure improvements in self-rated disability. Finally, they were asked whether they were satisfied overall with their surgical outcome. Wilcoxon signed rank tests were used to determine statistical significance ($p < 0.01$) between pre- and postoperative scores. *Summary of results:* Seventy-seven percent of the patients in this study were satisfied overall. The arm pain scores decreased from an average of 6.1 to an average of 1.8. The neck pain scores decreased from an average of 6.4 to an average of 2.7. The NDI decreased after surgery from an average of 24 to an average of 8. Seventy-seven percent of the patients returned to work or their pre-injury employment and/or daily activities. Nine percent of the patients had additional disc surgery. There were two complications early in the study. *Conclusions:* Cervical endoscopic discectomy is a safe and efficacious alternative to traditional cervical discectomy for the treatment of cervical radiculopathy and myelopathy. It provides rapid postoperative recovery with few complications and is less expensive than traditional open surgery.

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Endoscopic thoracic sympathectomy – review of 10-year experience. P.Y.K. Hwang, I. Ng, T.T. Yeo (Singapore)

Objectives, materials, and methods: Prior to 1993, we performed thoracic sympathectomy via the transthoracic and posterior paraspinal routes. Video-endoscopic sympathectomy was developed in our institute in 1993 for the treatment of palmar hyperhidrosis. Our initial experience was adapted from laparoscopic cholecystectomy equipment, using a three-port technique, and obtaining frozen sections of the sympathetic chain excised to confirm the sympathectomy. As we gained more experience, we found that a temperature rise of more than 1°C in the palm corresponded with good postsurgical results. *Results:* After more than 200 cases, we progressed to a two-port technique, with one port for viewing and one for coagulation of the chain. Today we perform the surgery through only one port, with temperature and laser Doppler blood flow monitoring of the palm. *Conclusions:* The patients benefit from reduced postoperative pain and discomfort, a small incision scar, same or next day discharge home, and long-term resolution of their palmar hyperhidrosis.

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Thoracoscopic sympathectomy for the treatment of hyperhidrosis. J. Liu, F. La Marca (Chicago)

Objectives: A retrospective review of 50 cases of thoracoscopic bilateral sympathectomies for the treatment of hyperhidrosis of the hands associated or not associated with hyperhidrosis of the axilla was carried out to identify the learning curve, the outcome and the complication rates of the technique. *Methods:* The records of 50 consecutive patients were reviewed to identify the following factors: operative time, successful outcome in terms of temperature and perspiration control, hospital time, and complications. Bilateral two-part sympathectomies of T2 and T3 were carried out for hyperhidrosis of the hands using an ultrasonic knife. The sympathectomy was extended to T4 and T5 if hyperhidrosis of the axilla was also present. The minimum follow-up was 6 months for all patients. *Results:* At follow-up all patients had maintained adequate long-term perspiration control. One patient had recurrence of temperature increase alone. Only one patient needed to return to the operating room for incomplete sympathetic chain incision. One case of postoperative blood pressure decrease occurred; however, this may have been secondary to narcotic usage for pain control. One patient required postoperative placement of a chest tube for pneumothorax, which resolved. No infections occurred. A steep learning curve was identified. Average operating time at the end of the curve was approximately 1 h. Most patients were dis-

charged from the hospital on postoperative day 1. *Conclusion:* Thoracoscopic sympathectomy is a safe and relatively fast surgical technique with a steep learning curve that yields a high rate of patient satisfaction in the treatment of hyperhidrosis.

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Free-hand endoscopic lumbar lateral recess decompression. M.M.W. Kotb (Cairo)

Introduction: Endoscopic surgery on lumbar disc prolapse has evolved in the last decade using standard microdiscectomy techniques as the standard means of treating such a common problem. Basically, the technique of endoscopic lumbar discectomy utilizes a speculum introduced through the back muscles, which rests on the lamina of the vertebra above the affected disc, and through which the endoscope and the instruments used to remove the disc are introduced. *Methods:* For the last 4 years, the author has been using the instruments developed by Destandau manufactured by Carl Storz Company. This set of instruments uses rigid working channels to introduce the endoscope, suction tube, and working instruments, in addition to a straight nerve root retractor. Despite its many advantages, the technique has two major disadvantages, which are the inability to use larger instruments because of the limitation of the diameter of the working channel and that the working channel does not admit curved instruments, making bilateral disc evacuation very difficult. To overcome these problems the author developed a mobile endoscope sleeve to allow free-hand introduction of the endoscope into the speculum leading to the introduction of larger and curved instruments as well as the endoscope to facilitate better disc removal. With this modification he was also able to use high-speed drills to decompress the nerve roots in cases of lateral recess stenosis. In this paper he presents this technical modification and the results of its use in his patients over the last year.

12 September, Friday: 17.50–19.00

Session XIV B

Free presentations: Hydrocephalus

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Indication and controversies for endoscopic third ventriculostomy in children. M.J. Fritsch, H.M. Mehdorn (Kiel)

Objectives: Controversy exists with regard to the indication for endoscopic third ventriculostomy (ETV) in subpopulations of children with hydrocephalus. Is ETV indicated in infants less than 1 year of age, in communicating hydrocephalus, in children with posterior fossa tumors, or in children with Chiari II? *Materials and methods:* We retrospectively reviewed 52 children who underwent ETV between January 1996 and December 2002. The average age at the time of surgery was 6 years and 3 months. The mean follow-up was 24 months. In particular, we evaluated the subgroups of patients mentioned above. *Results:* In the group under 1 year of age (20 patients) we had a success rate of 60% shunt-independent children. The other 40% failed and required a shunt. Patients who failed ETV had communicating (posthemorrhagic or postmeningitic) hydrocephalus. In the subgroup with posterior fossa tumors we performed ETV in only 5 patients. In 45 patients we elected early tumor removal instead of ETV and delayed surgery. In the group of patients with Chiari II (6 patients) we had 3 ETV failures in patients in whom ETV was the initial procedure for treatment of hydrocephalus. In 3 patients we removed a V-P shunt due to insufficiency and performed a successful long-lasting ETV. *Conclusions:* Age less than 1 year or prematurity alone do

not present contraindications or increase the perioperative risk for ETV. The successful outcome of ETV in this age group is dependent on the etiology of the hydrocephalus. ETV is indicated in infants with aqueductal stenosis and other forms of obstructive hydrocephalus. Due to the poor results, we do not see an indication for ETV in communicating hydrocephalus. ETV is not indicated in children with posterior fossa tumors for two reasons: only 5 out of 50 children required a CSF diverting procedure after tumor removal, and the anatomy of the interpeduncular cistern may be distorted due to compression. Initial treatment for hydrocephalus associated with Chiari II should be a shunt. In cases of shunt failure ETV presents a valuable treatment alternative.

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Endoscopic third ventriculostomy: which are the best candidates for intracranial pressure monitoring? A. Bellotti, A. Rapanà, C. Iaccarino, M. Pascale, M. Schonauer (Caserta)

Objectives: Endoscopic third ventriculostomy (ETV) has become the treatment of choice for noncommunicating hydrocephalus, being able to couple a high success rate (60–80%) with rare complications (about 5%). Nevertheless, which is the best postoperative care standard and which technique is able to assess promptly the early results of ETV are still under discussion. Traditional neuroimaging techniques have several limitations, mostly in the early postoperative period. Indeed, a decrease in the ventricular size is often minimal and is not visible until 3–4 weeks after the operation. MRI, able to detect the presence of a flow void signal through the third ventricle floor, has been reported to have a significant incidence of false positive results; furthermore, MRI cannot be used for daily control. *Materials and methods:* At our institution 25 consecutive patients ranging in age between 18 and 71 years (mean 40.7) affected by triventricular noncommunicating hydrocephalus underwent ETV. Among them there were 13 with aqueductal stenosis (AS), 5 with shunt malfunction, 2 with a third ventricle tumor, 3 with an intraventricular cyst, 1 with a quadrigeminal cistern arachnoidal cyst, and 1 with a midbrain esophytic mass. In order to evaluate the restoration of liquor circulation, all patients underwent continuous measuring of intracranial pressure (ICP) after the operation by means of a ventricular catheter (Codman Microsensor Ventricular Catheter) left in place. *Results:* ICP monitoring was of great help in verifying the correct functioning of the stoma during the first postoperative days and allowed us to deal safely with transient ICP increases of any grade that occurred shortly after ETV in as many as 52% of our patients (in about 40% of the cases more than one CSF subtraction was required to normalize ICP). No major complications occurred. *Conclusions:* Patients with intracranial mass lesions causing triventricular hydrocephalus and shunt-dependent patients, being more prone to developing severe intracranial hypertension after ETV because of their reduced compliance, should be considered for continuous ICP monitoring and close clinical follow-up.

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Endoscopic cathetering of the trapped fourth ventricle: report of three cases. R. González Rodríguez, C. Fernández Carballal, F.A. Gutierrez, R. Carrillo Yagüe (Madrid)

Objective: Our objective was to report our experience of endoscopic aqueductal cathetering as an effective treatment for patients with a trapped fourth ventricle. *Methods:* We report three adult patients with a symptomatic trapped fourth ventricle. The three patients had been previously treated for different hydrocephalus etiologies with ventriculo-peritoneal shunts. The first patient suffered a posterior fossa hemorrhage due to a cerebellar arteriovenous malformation. The second patient had been treated for a Chiari malformation 10 years before. The last patient had a complex congenital cerebral malformation. All the patients had progressive symptoms related to enlargement of the fourth ventricle.

We proceeded first with a ventriculostomy and with the help of endoscopic neuronavigation a catheter was introduced into the aqueduct and placed into the fourth ventricle. This catheter was shunted to a peritoneal catheter. *Results:* All patients underwent successful procedures with clinical improvement and radiological reduction of the size of the fourth ventricle. Two patients developed transient diplopia and dizziness, which resolved in a few weeks. *Conclusion:* In our experience endoscopic cathetering has been a safe and effective procedure for the treatment of a trapped fourth ventricle. The use of neuronavigation has been very useful for the correct placement of the catheter.

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Endoscopic stenting of the aqueduct for trapped fourth ventricle treatment. L.M. Sagan, I. Kojder, L. Madany, M. Lickendorf, M. Gizewska (Szczecin)

Objectives: Our objectives were analysis of endoscopic stenting of the aqueduct as an effective initial treatment for patients with trapped fourth ventricle (TFV) and to make a contribution to the study of the etiopathology of TFV on the basis of endoscopic observations. *Materials and methods:* Five cases of TFV treated by endoscopic aqueductal stenting were analyzed. Patients' ages ranged from 2 to 31 years (mean 13 years). In 3 cases hydrocephalus was a consequence of neonatal intraventricular hemorrhage, in 1 ventriculitis, and in 1 it developed after fourth ventricle subependymoma resection. All patients developed TFV at different times after initial shunting. A stent was placed endoscopically in 2 cases through a coronal burr hole approach and in 3 cases through a minimal suboccipital craniectomy approach. Mean follow-up was 14 months (range 9 to 16 months). *Results:* All procedures were successful and without complications. Postoperatively, 1 patient developed Parinaud's sign, rotatory nystagmus, and abducens nerve palsy, which resolved after the pre-existing supratentorial shunt was upgraded. There were no other complications. There were no cases of aqueduct re-occlusion. In 4 cases membrane-occluding orifice of the aqueduct was observed. There was no intraoperative evidence of aqueductal wall collapse. *Conclusions:* Aqueductal stenting is an effective method of TFV treatment. Due to the prevention of aqueduct re-occlusion by chronic inflammatory processes taking place in posthemorrhagic and postinfectious hydrocephalus, it evolves as more efficient than aqueductal plasty alone. Intraventricular chronic inflammatory processes leading to membrane formation play an important role in the occlusion of the cerebral aqueduct orifices and isolation of the fourth ventricle.

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Failure of endoscopic third ventriculostomy in myelomeningocele patients: preoperative clinical and radiological features. D.G. Walker, T.J. Coyne, R.J. Kahler, F.H. Tomlinson (Brisbane)

Purpose: We reviewed our results of endoscopic third ventriculostomies (ETV), and found a high rate of failure in patients with myelomeningocele (MM). *Methods:* Patients that had undergone ETV were retrospectively reviewed. In patients with MM, the CT appearance immediately preoperatively was also reviewed (including head circumference, AP and lateral skull dimensions, shape, bone thickness, scalloping, CSF spaces). Failure of ETV was defined as requiring a further shunting procedure. Patients were followed for a minimum of 1 year. *Results:* Seven patients with MM underwent ETV (aged 2.7–17 years, mean 12.2 years). There were no complications. The failure rate was 86% in this group (6 out of 7), compared with 28% in patients with other underlying pathologies (120 patients, hazard ratio 4.3, CI 0.9–21.3). All 7 had a previous shunt inserted before 2 months of age and these shunts had pressure differential valves with no antisiphon device. Pre-ETV imaging showed large lateral and third ventricles, but small or absent fourth ventricles. Preoperative CT scans showed characteristic features in the 6 that failed: thickened skull, scaphocephaly,

scalloping of the inner table, and prominent CSF spaces within the interhemispheric fissure. *Conclusion:* In our series, although safe ETV failed to make patients with MM shunts independent. These patients showed evidence of long-standing overdrainage, which may have contributed to the decreased capacity for CSF absorption. Prominent CSF spaces within the interhemispheric fissure (just proximal to the arachnoid granulations) may indicate poor CSF absorptive capacity and therefore a low likelihood of ETV success.

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Extraventricular intracisternal obstructive hydrocephalus: the concept and first clinical series. U. Kehler, J. Gliemroth, J. Regelsberger, M. Westphal (Hamburg)

Objective: The theory of extraventricular intracisternal obstructive hydrocephalus (EIOH) was invented to explain successful third ventriculostomies (3rdVS) in communicating hydrocephalus. The diagnosis is made when free communication between the ventricles and the great cistern coexisting with a downward bulged floor of the third ventricle is found. A direct visualization of an extraventricular obstruction is not usually detected. The experience with our first 12 patients with this hydrocephalus subtype is presented. *Patients and methods:* Twelve cases of suspected EIOH were identified. The surgical observations (resistant or soft floor of the third ventricle, adhesions in the prepontine cistern) and the outcome (good: clinical improvement with no shunt dependence; poor: shunt dependence) were assessed. The mean follow-up was 8 months. *Results:* In our 111 3rdVS we had 12 cases of EIOH (11%). Third ventriculostomy was successful in 8 cases (shunt independent) and poor in 4 cases. We found in 7 cases a rigid floor of the third ventricle that was difficult to penetrate, and 8 had adhesions inside the prepontine cistern. The cause of hydrocephalus was idiopathic in 7 cases, postinfectious in 2 cases, after intraventricular hemorrhage in 2 cases, and after posterior fossa surgery in 1 case. *Conclusion:* The success rate of around 67% (8 out 12) of 3rdVS in patients with apparently "communicating" hydrocephalus supports the concept of EIOH. The high number of prepontine adhesions could easily explain the intracisternal CSF pathway obstructions being partially responsible for EIOH. The concept has now been prospectively evaluated and supplemented with flow studies.

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Reduction in ventricular size after NTV: is this predictive of successful outcome and confirmation that NTV was the right choice? E. Sgaramella, G. Nurchi, S. Sotgiu, G. Pugliatti, A. Falzoi, F.M. Crotti (Sassari)

Objective: The objective of this study was to correlate reduction in ventricular size with successful NTV in our series of cases. In the literature, many authors report that the decrease in ventricular size is always minimal. The starting point of this study was the observation in our series of patients of a reduction in lateral and third ventricular width on a CT scan or MRI after an NTV procedure. *Methods:* For this reason, a retrospective study of pre-NTV and post-NTV size of the ventricles was carried out in an unselected series of patients undergoing this procedure. *Results:* The decrease in lateral and third ventricle size was seen as significant in patients with obstructive hydrocephalus. The mean reduction in lateral ventricle width was significantly greater in these patients. Lateral ventricle width provided higher positive predictive factor for a successful outcome (92%) than third ventricle width (88%). *Conclusion:* In conclusion, we observed a significant reduction in ventricular size. The area of debate is whether the radiological findings alone can predict the success or failure of the ETV. In our series, ventricular size reduction was coupled with a good clinical

outcome mainly in patients with obstructive hydrocephalus. For this reason we believe that post-NTV ventricular size reduction may be a good marker for a successful endoscopic procedure and confirmation that obstructive hydrocephalus is the best indication for NTV.

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After multiple CFS shunt revisions and complications – the neuroendoscopic third ventriculostomy could be the final solution. L. Vujotic, R. Repac, D. Grujicic, A. Repac, M. Kantardzic (Belgrade)

Objectives: There is a quite large group of patients who underwent multiple surgical procedures in an attempt to cure hydrocephalus, and who are still at great risk of further complications. The aim of this study is to focus our interest on them and give them hope for a successful end to treatment by performing neuroendoscopic third ventriculostomy and extracting all previous shunts. *Materials and methods:* At the Institute for Neurosurgery we perform approximately 300 shunt operations per year, 22% of which are revisions. The number of surgical procedures per patient is 2.5. In 1998 we started NTV (using standard Aesculap Rigid Endoscope and Fogarty 2–3F catheter), and we have operated on more than 180 patients, treating mostly patients de novo. There were a few patients who required surgery due to shunt insufficiency, but no other options were left other than to try NTV. *Results:* There were 5 illustrative cases (4 children and 1 adult) all treated for hydrocephalus in first months of life with classic CSF shunts, with a mean number of shunts per patient of 6.3. The mean age was 10.2 years (6, 7, 9, 14, and 23). In all cases postoperative CT showed good results, and neuro-ophthalmologic examination improved. *Conclusions:* We would like to suggest NTV as a physiology-friendly, simple, short, cheap, and modern procedure, not only in hydrocephalus de novo treatment, but also especially in those patients who suffered for years from various and multiple complications and required reoperations with no success. NTV gives them a rational hope and according to our experience the number of these patients will soon increase.

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Neuroendoscopy in the management of complex hydrocephalus: a new alternative for an old problem. Analysis of 34 cases. J.A. da Costa Val, T.R. Noci, A. Lara, G. Cariri, A. Locarno (Belo Horizonte)

Objectives: Complex hydrocephalus, with multiple cysts inside the ventricular system is a challenge for pediatric neurosurgeons. Conventional treatment, with multiple shunts, is often ineffective, as is the open approach. Endoscopic ventricle septostomy (VS) can transform a complex system into a single cavity, able to be treated with a shunt or another procedure. *Materials and methods:* In a series of 238 neuroendoscopic patients, 34 children were submitted to VS. Twelve of them were less than 1 year old. The main etiology was ventricular infection in a low-weight baby. Twenty-eight children were submitted to VS as a first neuroendoscopic procedure. The surgery was based on image studies. The approach was unilateral whenever possible. The goal was to connect as many cysts as we can, trying to unify the ventricular system. We attempted to avoid important structures and cranial collapse. *Results:* Out of 34 patients, 28 (82.3%) had intracranial pressure control after VS and posterior treatment with only one method (shunt or ETV). The complication rate was low, in contrast to traditional treatments. *Conclusions:* We conclude that VS is a useful procedure in patients with complex hydrocephalus. The goal is to transform a multicystic system into a single cavity able to be treated by one posterior surgery. The efficacy of VS is encouraging. The complications are few compared with traditional treatment.

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