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16 June, Thursday: 08.30–10.30

Session 1

Instrumentation, neuronavigation

1
Application of a novel endoscope for diverse intracranial pathology. J.R. Dusick, J.G. Frazee (Los Angeles)

Objective: We aim to demonstrate the utility of a newly developed neuroendoscope (Frazee Advanced Neuro-Endoscope; Karl Storz, Tuttlingen, Germany) for the treatment of diverse intracranial pathology. *Methods:* A neuroendoscope has been developed which offers numerous improvements over currently available scopes. The endoscope sheath is larger (9mm) allowing for more functional instruments to be passed down the scope. A larger viewing lens with a 6-degree angle provides high-resolution images and improved visualization of instruments exiting the tip. Irrigation at the tip makes clearing the lens and working field simple, without need to remove the scope or add irrigation catheters. The lens can be recessed into the sheath to prevent soiling during hematoma evacuation or brain biopsy. The larger diameter makes it more rugged and less prone to lens damage during use or sterilization. The endoscope and instruments are autoclavable. Improved instruments have been co-designed for this scope including true, squeezable bipolar forceps that are compatible with existing generators. Micro-scissors, suction and cup and grasping forceps are available in two sizes. The scope is compatible with standard endoscope holders and with image guidance, which is recommended for many procedures. *Results:* Ten procedures have utilized the new endoscope for various pathologies: septum pellucidotomy, supra-orbital incision/craniotomy for endoscopically-assisted clipping of ICA aneurysm, arachnoid cyst fenestration, periventricular tumor biopsy, suprasellar/3rd ventricular craniopharyngioma resection, two intraparenchymal hematoma evacuations, and three 3rd – ventriculostomies, one with a concomitant shunt revision. *Conclusion:* We present our initial experience with a newly designed neuroendoscope with numerous improvements over prior models. The

“Frazee Advanced Neuro-Endoscope” has superior optics, an integrated self-irrigating tip, improved visualization of instruments and improved instrument maneuverability. Several useful instruments designed for the scope include true bipolar forceps capable of squeezing tissues for accurate cautery. This scope has been used on various intracranial pathologies with promising results.

2
Endoscopic cystoventriculostomy and ventriculo-cisternostomy using a 2.0 micron fiber guided high power diode pumped solid state (DPSS) laser. H.C. Ludwig, T. Kruschat, T. Knobloch, K.M. Rostasy, H.O. Teichmann, M. Buchfelder (Göttingen, Katlenburg)

Objective: Preterm infants have a high incidence of posthemorrhagic or postinfectious hydrocephalus often coincident with ventricular or arachnoid cysts and the risk of entrapment of the cerebrospinal fluid (CSF). In these cases fenestrations of separating membranes is the purpose of neurosurgical therapy. Although Nd:YAG- and diode-lasers have been already used in neuroendoscopy, surgeons avoid to use high energy lasers in proximity to vital structures depending on the occurrence of side effects. *Patients and methods:* We have used a recently developed diode pumped solid state (DPSS) laser emitting light at wavelength of 2.0 μm (LISA laser products, Katlenburg, Germany), which can be conducted through silica fibres into endoscopic targets. Due to the strong absorption of the 2.0 μm laser radiation in water no side effects occur. From July 2002 until December 2004 16 consecutive patients between 3 months and 24 years old underwent 14 endoscopic procedures. Most children suffered from complex posthaemorrhagic and postinfectious hydrocephalus with entrapment of CSF. We performed two ventriculostomies in patients with occlusive hydrocephalus. We used two different endoscopes, a 6 mm Neuroscope™ (Braun Aesculap, Melsungen, Germany) and a 4 mm Miniatur Neuroscope™ (Storz, Tuttlingen, Germany). The beam was conducted through a 360 μm bare silica fibre introduced through the endoscope's working channel. The energy was adjusted to levels between 5 and 10 Watts at frequencies between 5 and 20 Hz or running in continuous mode. *Results:* CSF communication was achieved in all cases. There was no mortality of morbidity attributable to the technique. In some patients with cystic compression of the 4th ventricle a shunt could be avoided. *Conclusion:* The authors conclude that the use of the new Revolix™ 2.0 micron cw laser enables safe and effective procedures in neuroendoscopy.

3
A transparent sheath for endoscopic surgery and its application for surgical evacuation of spontaneous intracerebral bleeding. T. Nishihara (Tokyo)

Objective: In microsurgical treatment of intracerebral haemorrhage an immediate intervention including a minimal damage of

brain tissue and a maximal volume evacuation with secure haemostasis is required. *Material and methods:* We have developed a transparent guiding sheath and other surgical instruments for endoscopic surgery, and established a novel operative technique under emergency conditions using those instruments. This procedure has the following characteristics: 1) Capability of burr hole approach under local anesthesia. 2) The transparent sheath improves the surgical field visualization in the parenchyma and the hematoma. 3) Free-hand surgery without fixing the endoscope and the sheath to a frame facilitates the three-dimensional approach. 4) The capability of secure hemostasis by electric coagulation. When bleeding from a perforating artery occurs a suction tube is placed at the bleeding source and hemostasis is achieved by electric coagulation. 5) Easy preparation with relatively simple instruments. *Patients:* We have performed this procedure in 91 patients with intracerebral or intraventricular haemorrhage. Among 91 patients, 24 patients were operated on using the ultra-early stage technique, or within 3 hours after onset. The main duration time of surgery was 63 minutes, the mean hematoma reduction rate was 96%. No perioperative haemorrhage with deterioration of symptoms occurred. *Conclusion:* We believe that endoscopic hematoma evacuation using our surgical procedure is a promising ultra-early-stage treatment for intracerebral haemorrhage. It may improve the long-term prognosis of patients with intracerebral haemorrhage.

4

Videoneuroendoscopy versus fiberneuroendoscopy: an experience. V. Dallolio, M Boccardo* (Lecco, Nanavecchia*)

Objective: Aim of this paper is to demonstrate the optimized vision in neuroendoscopy by a "new" optic system: the videoneuroendoscopy. The discussion is always open between the advocates of steerable fiberscope and those who prefer rigid lens endoscopes. It is clear that the rigid lens endoscope shows a top quality of optic vision, while the steerable fiberscope allows more manoeuvres to limited anatomic spaces like the ventricular system. *Material and methods:* We updated the technical development of miniaturized optic instruments to find a system that targets the top quality of endoscopic vision and outstanding application. The technology of gastroscopy, colonoscopy, etc. (chip size 14-16 mm) were not useful for micro-neurosurgical requirements. More miniaturization of the chromatic chip with a higher optic definition was needed. *Results:* Finally we were successful to reduce the size in such an amount and to plan a new instrument adapted, which could be used in accordance to the demands of neuroendoscopy. In this experimental study using the (steerable) videoneuroendoscope (video-brochoscope, Olympus Co.) 3rd ventriculostomies performed with a lenscope were checked. *Conclusion:* The results of this study emphasizes the advantages of videoneuroendoscopy with optimal optical properties and "steerability" in one single instrument.

5

Increased possibilities and safety of neuro-endoscopic procedures by integration of endoscopes and image-guiding systems. T. Beems (Nijmegen)

In the last decade neuro-endoscopy has gained an enormous popularity. This is mainly due to the minimally invasiveness of the procedure allowing a fast recovery. The interest in neuro-endoscopy was supported by numerous publications reporting good results with high success ratios. Last years, however, more attention has been given to the complications and limitations of neuro-endoscopy. Most of this attention concerned medical complications and clinical failures, but reports about technical failures also appeared. These technical failures are mostly caused by the impossibility of the surgeon to recognize the (para-) ventricular anatomy and so termination of the procedure, or the use of a wrong endoscope tra-

jectory causing limitations in completing planned procedures. Neuro-endoscopists therefore can benefit from an instrument that aids in determining the optimal surgical trajectory and recognizing CSF space (-related) anatomy. This instrument is now widely available with different Image Guidance Surgery (IGS) systems. These systems have been developed for surgical planning and recognizing anatomical relationships. In fact the weak aspects of endoscopes are the strong items of Image Guidance Systems! The easily blurred vision, limited field of view and possible unknown exact direction of endoscopes can be counterbalanced by IGS systems because the relation with surrounding structures and direction of navigated instruments are excellently shown by the computer independently. So endoscopes and IGS systems are complementary. It is necessary however that the endoscope can easily be integrated in the IGS system. The surgeon should also be aware of the difficulties that can be encountered in a navigated endoscopic procedure and how these can be solved. But when applied in the right way the possibilities of neuro-endoscopic procedures are increased by integration in an IGS system. The best entry point and trajectory of endoscopes can exactly be defined preoperatively and the surgeon is supported in the recognition of anatomical structures and -relationships. Therefore the success ratios and effectiveness, but also the safety of the procedures are increased. Image guidance is not necessary in all neuro-endoscopic procedures, but is valuable in procedures with distorted anatomy, high risk of intra-operative hemorrhages (disturbing the endoscopic view), very large CSF spaces and in cases with multiple targets. The integration of endoscopes in an IGS system, the technical problems that should be dealt with and new developments in the IGS-systems making this easier are discussed with multiple cases to demonstrate this.

6

Neuronavigated endoscopic procedures in paediatric patients. G. Zuccaro, F. Sosa, R. Jaimovich, V. Cuccia (Buenos Aires)

Objective: The purpose of this paper is to report our experience in the use of frameless neuronavigation and endoscopy. *Patients and methods:* Between January and December 2004, 192 endoscopic procedures and 87 navigation-guided surgeries were performed at the Hospital Nacional de Pediatría "Juan P. Garrahan". Both neuronavigation and endoscopy was used in six patients to achieve precise location of the intraventricular pathology. Surgery was performed on 3 girls and 3 boys ranging from 7 to 10 years of age. They presented the following pathologies: 3 arachnoid cysts (either next or within the ventricular system), one excluded ventricle, one porencephalic cavity and one hypothalamic tumour extended to the third ventricle. The combination of neuronavigation (BainLAB, Vectorvision II) and neuroendoscopy was due to the small ventricular size. *Results:* The precision of the neuronavigational registration was always below 1 millimeter, however, we were not able to access the ventricular cavity in one of six patients. In five cases neuronavigational approach planning makes it possible, to reach the intraventricular pathology without deviation. *Conclusion:* We believe that the combination of neuronavigation and neuroendoscopy is of utmost importance to perform endoscopic interventions in a normal sized ventricular system.

7

Image guided neuroendoscopy in paediatric patients – the Malaysian experience. V. Waran (Kuala Lumpur)

Objective: To review our experience in image-guided endoscopy in the management of ventricular system related pathology in paediatric patients. We also aimed to assess the accuracy of ENT DRF (Dynamic Reference Frame) in conjunction with image-guided endoscopy. *Methods:* A retrospective study of all paediatric patients operated on endoscopically combined with image-guidance at our

centre was undertaken. The cases were reviewed for indication, outcome and complications encountered. Seven procedures were performed in the last 12 months. Patients' age ranged from 4 months to 11 years. The operations included four endoscopic fenestrations for multiseptated hydrocephalus or cystic lesions related to the ventricular system, two endoscopic third ventriculostomies, and one pineal region biopsy combined with a third ventriculostomy. *Results:* We were able to plan our trajectories in all or patients and achieve our operative goals. There were no procedure related complications. One infant with an obstructive hydrocephalus required shunt application six weeks after endoscopic third ventriculostomy. Image guidance did not prolong the operative time. The planning of the accurate trajectory made it possible to guide the endoscope through the ventricular system without injuring neuronal tissue of the surrounding structures. *Conclusion:* The use of image guidance (ENT DRF) in conjunction with endoscopy allowed the planning of accurate trajectory making the procedure safer.

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Red out control in neuroendoscopy with the VN-system. M. Scholz, P. Heinen, B. Fricke, S. Tombrock, A. Harders (Bochum)

Objective: The newly developed VN (visual navigation) system uses previously stored endoscopic images for navigational purposes. If the real endoscopic image is lost e.g. due to bleeding with a red out situation the modal "red out control" enables graphic overlay of the coagulation fiber into such images. *Material and methods:* A 5.9mm rigid endoscope (Caemaert, Wolf Co.) was linked to an optical position measurement system. Calibrated endoscopic images together with 3D data of the current endoscope position were transferred to a personal computer with the developed VN software. This images were sampled during the approach inside the operative field. The system was tested in animal experiments (rats) as well as in a special designed semibiologic simulator. *Results:* Red out control with the red out module is possible with a success rate of more than 85%. The developed simulator was extremely suitable for testing of the module. Training of the neurosurgeon using the VN-system can be performed with the described simulation system. *Conclusion:* In the future specially semiautomatic landmark tracking will be the key for the development of intelligent neuroendoscopic red out control.

16 June, Thursday: 10.45–12.15

Session 2

Hydrocephalus I: Endoscopic third ventriculostomy under 2 years of age

9

Surgical anatomy for endoscopic third ventriculostomy. L.M. Cuello, E. Gagliardi, O. Konsol (Buenos Aires)

Objectives: ETV is a popular procedure in the treatment of special types of hydrocephalus. It is applied with increasing frequency and is at present time a standard tool in neurosurgical practice. Understanding of the anatomy of the ventricular system, the basal cisterns, and their relationship to important neural and vascular structures is essential for application of ETV. The authors describe the knowledge, which is considered essential to carry out ETV, the risks associated with the damage of vital structures located around the CSF pathways, and the anatomical variations of surgical importance they found in their personal experience. *Material and*

methods: Formalin fixed cadaveric specimens were utilized for the anatomical demonstration of the involved structures as well as recordings of the authors' surgical procedures. The structures not visible using the endoscope (e.g. internal capsule, hypothalamus, etc) were drawn on the photograms. Anatomical variations found by the authors' surgical practice were also registered. *Results and conclusions:* The standard transcortical approach to the lateral ventricle was preferred. Care must be taken to avoid the damage of important anatomical structures such as fornix, hypothalamus, basilar artery etc.. Amongst the malformations and anatomical variations which have been found, the most common is the opacity of the third ventricular floor. Other detected variations are: protrusion of the basilar tip, displastic basilar artery contacting the dorsum sellae, and a bridging vessel crossing the third ventricle under the hypothalamic sulcus.

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In utero treatment of foetal hydrocephalus, report of a single case. Should this be continued? M. Vloeberghs, K. Nicolaidis* (Nottingham, London*)

Objective: This paper presents a single, exceptional case where a Neuroendoscopic Third Ventriculostomy (NTV) was done in utero. This report aims to demonstrate the feasibility of in utero NTV and to raise the ethical questions regarding this procedure. *Case:* Mid 1998, a couple presented to the Foetal Maternal Medicine unit at Kings College with hydrocephalic foetus at 18 weeks at gestation. The foetus had been conceived by in-vitro fertilization. The hydrocephalus presented as an "Aquaduct pattern" e.g. dilatation of the supratentorial ventricles, with normal fourth ventricle. The pregnancy markers and karyotype of the foetus were normal. As the hydrocephalus was progressive and on specific demand of the parents treatment options were sought. After consultation, Neuroendoscopic Third Ventriculostomy was the method of choice. The experience of both units was combined, urgent ethical was obtained and legal disclaimers were signed. *Method:* Foetus at 22 weeks of gestation. The mother was given a slight sedative and local anaesthetic was applied to the entrypoint of the foetoscope. The foetoscope was used to puncture the uterus and the foetal skull under ultrasound guidance. The lateral ventricle was punctured and from there on Neuroendoscopic Third Ventriculostomy was done under direct vision, through the left foramen of Monro. There were no anatomical difficulties or differences in texture compared to neonates. After NTV an ultrasound of the foetus was done showing the decrease in the ventricular size and no blood in the ventricles or in the subarachnoid space. Eight hours after the procedure, the mother developed contractions. A new ultrasound showed hyperdense blood in the subarachnoid space and signs of bleeding in the internal organs e.g. a picture of diffuse Intravascular Coagulopathy. In utero transfusions were given but the foetus died within a few hours and labour was induced. The mother remained unharmed and received adequate counselling after the event. *Conclusion:* This case has never been published and remains a single case. The pattern of progressive hydrocephalus in the foetus and the explicit demand of the parents led us to perform the procedure. This event has proven in utero NTV to be feasible, but raised many questions about methodology and ethics particularly because of the poor prognosis of hydrocephalus early in gestation.

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Endoscopic third ventriculostomy (ETV) in infants under one year of age: A German multicenter study. M.J. Fritsch, U. Kehler, A. Joedicke, J. Boschert, W. Wagner (Kiel, Hamburg, Giessen, Mannheim, Mainz)

Objective: Controversy exists, whether there is an indication for ETV in infants. The question remains if age on rather etiologic in-

fluences the outcome. *Patients and methods:* In a multicenter retrospective analysis we evaluated the outcome of 87 infants who had undergone ETV. Finally included in the study were only patients who at least 2 years follow up after the procedure (n=58, 26 female, 32 male). Age at the time of surgery was 1-354 days (mean 119 d). Follow up was 26-89 months (mean 48 months). Patients were evaluated regarding the influence of age and etiology on the success or failure of the procedure. *Results:* Patients with isolated idiopathic aqueductal stenosis (AS) had a success rate of 50% at 2 years follow-up. Patients with other pathologies (intraventricular hemorrhage, meningitis (MMC) did not demonstrate long lasting sufficiency of ETV. The success rate of ETV increased with age, independently from etiology. *Conclusion:* Etiology and age seem to influence the long term sufficiency of ETV in infants under one year of age. However, the only patient group that clearly benefits from the procedure are patients with isolated idiopathic aqueductal stenosis

12 Endoscopic third ventriculostomy in children younger than 2 years of age. J. Baldauf, M.R. Gaab*, H.W.S. Schroeder (Greifswald, Hannover*)

Objective: Endoscopic third ventriculostomy (ETV) for the treatment of hydrocephalus of different etiologies is still controversial in children younger than two years of age. The success rate of ETV in this group of patients is analysed in this study. *Patients and Methods:* The series consisted of 21 patients treated with ETV. The mean age was 6.7 months, ranging from 9 days to 15 months (16 patients were younger than one year). The study included hydrocephalus due to aqueductal stenosis (9), and other congenital anomalies (5), as well as posthemorrhagic (3), and tumor-related occlusive hydrocephalus (2). Two patients presented with shunt infection and one with shunt failure. ETV was considered to be successful when shunting could be avoided. *Results:* We found no procedure-related complications. ETV was successful in 9 patients with a mean follow up period of 26.2 months. Only one patient received a re-ETV after 2 months. In 12 patients ETV was unsuccessful after a mean follow up of 3.3 months (all patients with a previous shunt, 4 with aqueductal stenosis, 3 with congenital anomalies, 1 posthemorrhagic hydrocephalus, 1 tumor-related hydrocephalus). These patients required a CSF shunt. Ten of them were less than one year old, when ETV was performed. *Conclusion:* Our results show a success in 43% of the children treated by ETV. It must be noticed, that shunt implantation was mainly required in children less than one year of age. The results support the necessity of a prospective randomised trial concerning the efficacy of ETV versus shunts in this group of children.

13 Endoscopic third ventriculostomy after previous shunt procedures in the age under six months. L.J. Vujotic, M. Jovanovic, V. Bascarevic, S. Ivanovic (Belgrade)

Objective: The efficacy of endoscopic third ventriculostomy in infants under 6 months of age is discussed controversially. However, this does not mean that ETV cannot be applied in children who underwent multiple shunt revisions to cure hydrocephalus, including those who were operated the first time before six months of age. *Patients and methods:* In our institute we perform approximately 300 shunt interventions per year, including 22% shunt revisions. The mean number of surgical procedures per patient is 2.5. Starting with ETV in 1998, we have operated on 170 patients, most of them without former intervention, but also some patients after multiple shunt revisions, who required surgery, without any other option left. *Results:* 5 patients (4 children, 1 adult) were treated in the first months of their life with classic CSF shunts.

Mean age of the patients was 10.2 years and the mean shunt revision rate was 6.3 in this group. One boy (6 years old), with an aqueductal stenosis, moderate PMR, was treated successfully by ETV for the 5th and final time, and is doing well 25 months after surgery. Another 7 years old boy, with a large parietal porencephalic cyst and hydrocephalus, suffered from recurrent CSF infections, ventriculitis and sepsis. He was under poor conditions prior ETV. After surgery (9th procedure) and removal of the shunt material, he slowly recovered, is now – 13 months later – able to talk and walk. A nine year old girl have been operated on three times with excellent mental and psychological profile, but showing moderate symptoms (chronic papillary edema and slightly impaired vision). After ETV she is doing well, no clinical signs of increased ICP and improvement of ocular symptoms. A boy (14 years old) underwent ETV after multiple shunt operations (bilateral peritoneal, bilateral atrial, revisions etc.) is now cured. All devices could be extracted. The last case is an adult patient, who was shunt-dependent after intrapartur haemorrhage. He had four interventions because of shunt complications and a great benefit of ETV. He is now shunt-free, active and socially integrated. In all cases postoperative CT scan showed good results and neuroophthalmologic signs also improved. *Conclusion:* We suggest ETV as a physiological, simple short and cheap procedure, not only in de novo hydrocephalus, but especially in those patients who suffered over years from various and multiple shunt complications causing re-operations with no success. ETV gives them rational hope and according to our experience the number of patients will increase soon.

16 June, Thursday: 13.00 – 14.30

Session 3

Hydrocephalus II: Endoscopic third ventriculostomy – various indications and results

14 Outcome of 205 unselected endoscopic third ventriculostomies for adult obstructive hydrocephalus: the Turin experience. A. Ducati, M. Fontanella, R. Boccaletti, M. Naddeo, F. Griva, F. Tartara, S. Borgarello, F. Faccani, V. Luparello (Torino)

Objective: Endoscopic third ventriculostomy (ETV) is nowadays the treatment of choice for noncommunicating hydrocephalus, but its real surgical risk and failures are yet unclear. The aim of this study was, to describe the complications and the early failure rate of ETV on a large unselected series of adults treated in three neurosurgical centres, covering all the population area of Turin, Italy (about 1 million of inhabitants). *Patients and methods:* From January 1997 to December 2004, all patients admitted for obstructive hydrocephalus in the three centres underwent ETV as first choice surgical treatment (205 cases; 133 males, 72 females; median age: 54 years). The etiology of hydrocephalus was primary aqueductal stenosis in 88 patients (43%), tumorous lesions in 62 (30%) and non-tumorous space occupying lesions in 42 (21%). Thirteen patients (6%) had a post-hemorrhagic obstructive hydrocephalus. Ninety-seven patients presented with acute clinical onset (47%). Surgical morbidity, clinical outcome and ETV failure were evaluated at 3 months. *Results:* Surgical complications occurred in 11 cases (6 intracerebral hematomas, 5 intraventricular hemorrhages, 1 CSF infection): 3 of them died. 166 cases (81%) had a clinical improvement at 3 months, 31 (5%) were unchanged. Permanent neurological deterioration occurred in 8. Early failure of ETV within 3 months occurred in 35 cases (17%), requiring a perma-

shunt in 21. **Conclusions:** ETV in obstructive hydrocephalus had a 3 months success rate of 83%. Surgical complications (5.4%) and permanent neurological deterioration (3.9%) should be taken into account in advance because they are not negligible.

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Indications and problems of third ventriculostomy. K. Kurisu, A. Tominaga, T. Saitoh, K. Sugiyama, K. Arita (Hiroshima)

Objective: To discuss the indications and problems of third ventriculostomy (TVS) from our experiences. **Patients and methods:** Forty-one cases of TVS performed by one surgeon (AT) in Hiroshima University Hospital and the affiliated hospitals from 1997 to 2003. Age range: 7 months to 79 years (median 17 years); male/female ratio: 24/17. Follow-up periods: 2–70 months (median: 26 months). Causes of hydrocephalus were tumours in the posterior part of the third ventricle (18 cases); CSF-flow obstruction in the 4th ventricle caused by brain tumour (10 cases), aqueductal stenosis (6 cases); shunt malfunctions in aqueductal stenosis or Chiari malformation (5 cases) and other congenital malformations (2 cases). The flexible fiberscope was used in 40 cases, the rigid type only one time. Furthermore the ME-2 and balloon-catheters were applied. **Results:** Among 18 cases with tumours located in the posterior part of the 3rd ventricle TVS was very effective in 12 patients, effective in 5 patients and without improvement in one case. TVS was very effective in 5 patients with 4th ventricle tumours, effective in 3 patients, ineffective in 2 patients. For aqueductal stenosis TVS was very effective in two patients with acute symptoms and in 2 patients without acute symptoms. Five cases with shunt malfunction previously inserted for treatment of aqueductal stenosis and Chiari malformation improved after TVS. **Conclusion:** Obstructive hydrocephalus caused by primary aqueductal stenosis or tumours in the posterior part of the third ventricle and in the fourth ventricle presenting with acute symptoms due to raised ICP are a good indication for TVS. TVS is also effective in cases with VP-shunt malfunction in obstructive hydrocephalus. In children under 2 years of age the application of TVS seems to be less successful.

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Factors affecting the success of endoscopic third ventriculostomy: experience in 102 patients. V. Etus, I. Anik, K. Koc, S. Ceylan (Kocaeli)

Objective: Endoscopic third ventriculostomy (ETV) avoids placement of cerebrospinal (CSF) shunt systems, and has thus revolutionized the management of hydrocephalus. The indications for ETV continue to expand as neurosurgeons' experience with this procedure grows. **Patients and methods:** We present a retrospective analysis of our experience with 102 patients who underwent this procedure between 1997–2005. We also discuss the controversial issues related to ETV including age and indications. Our patient population was heterogeneous, ranging in age from 4 weeks to 67 years, with different types of hydrocephalus. **Results:** After ETV there was no permanent morbidity and no mortality in our series. The overall success rate was 69.6%. ETV success rates were analysed in accordance to etiology of hydrocephalus, patients' age, preoperative CSF diversion status and history of infection or haemorrhage prior to the procedure. The highest success rate (88%) was found in patients presented with obstructive hydrocephalus, who had no history of infection or hemorrhage. However, ETV was found to be successful in nearly half of the patients with previous infection or intraventricular bleeding and in pediatric patients younger than two years. This means that such individuals may remain shunt-free for their whole life.

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Endoscopic third ventriculostomy in the adult population: a review of indications and outcome. Y.C. Gan, A. Taha, R. Joseph, A.R. Walsh, G. Flint (Birmingham)

Objective: To evaluate efficacy of third ventriculostomy (ETV) in adult patients with obstructive hydrocephalus. **Design:** Retrospective study of patients that underwent ETV from 1995–2004. Age, sex, pathophysiology, follow-up duration, success of procedure and symptom free period was recorded. **Subjects:** 115 patients (63 males, 52 females) underwent 119 ETVs (4 revisions). Age ranged from 16–80 years (mean=43). 33 patients (29%) had prior shunts. Follow-up 3 to 84 months (mean=12). **Outcome measures:** Objective outcome: failure is defined as further surgery for hydrocephalus; early failure <3 months, late failure 3–6 months. Subjective outcome: symptomatic improvement. **Results:** Objectively, 76 successful procedures (66%), and 39 failures (34%) – 27 early and 12 late. 16/39 (41%) of failed procedures had previous shunts compared to 17/76 (22%) successful procedures. 71 patients (62%) reported symptomatic improvement, 5 (4%) no improvement and 39 (34%) had worsening symptoms. **Mortality:** 8 deaths, 4 GBM, 3 IVH, 1 MI and 1 cerebellar rebleed. **Complications:** 2 transient diabetes insipidus, 2 transient Horner's syndrome, 2 menstrual irregularities and 1 epilepsy. **Conclusion:** ETV is as effective in the adult as in the paediatric population in treating hydrocephalus with success rate of 66% and with minimal complications. Higher success rate is achieved with aqueduct stenosis, tumours and colloid cysts. Previous shunts are a strong negative predictor of a successful outcome.

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Endocrine evaluation following endoscopic third ventriculostomy (ETV) in children. M.J. Fritsch, M. Bauer, C.J. Partsch, H.M. Mehdorn (Kiel)

Objective: ETV is a standard procedure for treatment of obstructive hydrocephalus in children. The main part of the procedure is the perforation of the third ventricular floor (tuber cinereum). This structure is part of the hypothalamus – pituitary neuronal network of cerebral endocrine regulation. So far there are no systematic data available about endocrine dysfunction following ETV in children. **Patients and methods:** We examined 20 children who had undergone ETV postoperatively. Examinations included laboratory tests (Cortisol, ACTH, Prolactin, IGF-1, IGF-BP, FSH, LH, fT3, fT4, TSH, Serum, Osmolarity, Electrolytes, Glucose, Urea) measurements of weight, height, head circumference; physical examination; in selected patients x-ray of the left hand. The study had received the ethic commission vote. Consent was obtained from parents. **Results:** The most obvious abnormality was mild Prolactin elevation in 9 out of 20 patients. In all 9 patients, this was the only laboratory value, that was distorted, all other parameters were normal. Three other patients showed one value abnormality (decrease in FSH and LH, increase in TSH, decrease in IGF-1 and IGF-BP). Nine patients demonstrated irregularities in their weight or height development when plotted to the age determined percentile curves. **Conclusions:** We conclude that more patients than expected demonstrated endocrine abnormalities. It has to be considered that some of the patients may have endocrine abnormalities secondary to their primary disease (tumour, trauma, meningitis). However, ETV may contribute to distortion of endocrine values in pediatric patients. Our conclusion is: 1. Endocrine distortion should be discussed when obtaining the preoperative consent. 2. Further studies are necessary, especially pre- and post-operative endocrine evaluation.

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Assessment of the influence of operative factors in the success of endoscopic third ventriculostomy (ETV) in children. D. Kombogiorgas, S. Sgouros (Birmingham)

Introduction: It has been suggested that the success rate of endoscopic third ventriculostomy (ETV) in treatment of hydrocephalus may be influenced by operative factors. *Objective:* To determine if the following operative factors correlate with success of ETV; intra-operative haemorrhage, size of stoma (percentage of stoma diameter to distance between posterior clinoid-basilar artery), thick or double 3rd ventricular floor, presence of pre-pontine adhesions, brisk CSF flow through the stoma. We analysed also the influence of hydrocephalus cause, previous shunt presence, CSF infection or haemorrhage, and previous ETV. *Patients and methods:* A review was performed of 33 hydrocephalic children treated by ETV, in whom video of the procedure and a minimum follow-up of 1 year has been available. Mean age at operation was 76 months (range: 1-196). Previous shunt was present in 16 patients. Success was defined as no need for shunt long-term. *Results:* Overall success rate of ETV was 42%. Mean stoma size was 37%. In individual Chi-square analysis none of the operative factors correlated statistically with success. A stoma size more than 35% did not correlate with success ($p=0.358$). The only factors that adversely correlated significantly with success were previous shunt presence ($p=0.008$) and previous history of CSF infection including shunt infection ($p=0.011$). Significance remained in multi-factorial linear regression analysis. *Conclusion:* While it is often said that the presence of pre-pontine adhesions, double or thickened floor of 3rd ventricle and small size of the stoma correlate with poor success rate of ETV, this study did not demonstrate such a correlation.

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Endoscopic 3rd ventriculostomy in haemorrhage-related hydrocephalus: a report of 30 cases. J. Oertel, H.W.S. Schroeder*, M.R. Gaab (Hannover, Greifswald*)

Objective: Endoscopic third ventriculostomy is still under debate for the treatment of acute hydrocephalus caused by intraventricular hemorrhage and consecutive blockage of the aqueduct. *Patients and methods:* From 1994 to March 2005, 30 endoscopic procedures were performed by the authors for haemorrhage related hydrocephalus. All patients were prospectively followed. The patients (12 male, 18 female; mean age 56 years, ranging from 3 months to 83 years). Consisted of 16 cerebellar haemorrhages primarily rupturing into the 4th ventricle and 14 thalamic haemorrhages affecting the 3rd ventricle. There were 28 hypertensive haemorrhages, one angioma bleeding and one perinatal haematoma. All patients presented with impaired consciousness, with 21 in comatous state. On CT all patients suffered from occlusive hydrocephalus. A 3rd ventriculostomy was performed in all patients. The haematomas were partially removed endoscopically in 15 cases. *Results:* There was no procedure related mortality. One intraoperative re-bleeding was controlled endoscopically. There was one postoperative infection. Ventricular size decreased post-surgically in 21 cases (70%). Fifteen patients improved clinically immediately after the intervention (50%, with 2 patients who were asymptotically after surgery). Ten patients remained unchanged (33%) and further 5 deteriorated (17%). The mortality rate was 33% (10 patients). *Conclusion:* In all patients endoscopic ventriculostomy represents a safe and successful treatment option for haemorrhage related hydrocephalus with similar results as compared to external ventricular drainage treatment, but less risk of postoperative infection. Particularly, in cases in which the clinical symptoms are mainly caused by hydrocephalus, endoscopic third ventriculostomy seems to be the procedure of choice.

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Endoscopic third ventriculostomy for occlusive hydrocephalus due to cerebellar infarction. J. Baldauf, M.R. Gaab*, H.W.S. Schroeder (Greifswald, Hannover*)

Objective: The surgical management of occlusive hydrocephalus due to massive cerebellar infarction still remains controversial. To our knowledge this is the first report of using endoscopic third ventriculostomy (ETV) in patients with occlusive hydrocephalus caused by cerebellar ischemic stroke. We report our experience of 10 reviewed cases. *Patients and methods:* Between 1997 and 2004 10 patients with a hydrocephalus due to a space occupying cerebellar infarction were managed with ETV. Glasgow coma Score (GSC) on admission, cause of stroke as well as computed tomographic (CT) signs, including the involved ischemic vascular territory and the brain edema were noted. Clinical outcome was evaluated by the Glasgow outcome score (GOS). *Results:* There was a mean interval of 4 days from the onset of deterioration of consciousness to operation in all patients. Mean GCS on admission was 11.2. In nine patients ETV was the initial procedure, one patient was primarily treated with EVD, but the device dislocated and ETV was performed. In 1 patient an EVD was necessary 7 days after the initial ETV due to a malfunction of the stoma. One patient showed a progressive brain edema 2 days after ETV and suboccipital decompression was performed. Eight successfully treated patients demonstrated an improvement in the level of consciousness after ETV. Mean GOS on discharge was 3.4. *Conclusions:* Occlusive hydrocephalus due to cerebellar infarction is less frequent. When noticed, ETV can be used successfully with minimal risks, especially with avoidance of a higher rate of infectious complications caused by external drainage systems.

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Hydrocephalus and Chiari Type I malformation: the role of endoscopic third ventriculostomy (ETV). C. Cereda, R. Stefani, R. Bergomi, A. Bollati, F. Giordano*, F. Mussa*, L. Genitori* (Brescia, Firenze*)

Objective: Chiari Type I malformation is correlated with hydrocephalus in about 7% of the cases. The common treatment of this associated pathology is posterior decompression (PFD) and CSF diversions and is well described. More recently ETV, solving both hydrocephalus and tonsillar herniation, gains in importance. Aim of this study is to clarify the efficacy of ETV treating clinical symptoms and improving radiological findings in Chiari Type I malformation correlated with hydrocephalus. *Patients and methods:* Between 1998 and 2005 16 patients with CMI malformation and hydrocephalus underwent an endoscopic third ventriculostomy. Syringomyelia was present in 5 cases. 11 patients were children and 5 adults. 10 cases treated by ETV, 4 patients needed a posterior fossa decompression (PDF) as a second intervention, because there was no improvement of symptoms. 2 adult patients primarily treated by PFD and VP-shunt insertion were treated by ETV and shunt-removal. *Results:* Both neurological and radiological signs improved in all patients. All patients remained shunt free. *Conclusion:* As a consequence of our data, we suggest that ETV can be the first surgical option for Chiari Type I malformation associated hydrocephalus. Both pathological conditions and related syringomyelia can be cured by ETV in the majority of cases. ETV is a safe and minimally invasive procedure. No complications were noted in our series.

16 June, Thursday: 14.45–16.15

Session 4

Neuroendoscopy and arachnoid cysts

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Neuroendoscopic approach to arachnoid cysts – long-term results. J. Baldauf, J. Oertel*, M.R. Gaab*, H.W.S. Schroeder (Greifswald, Hannover*)

Objective: Neuroendoscopic approaches to arachnoid cysts have already become an alternative treatment option to microsurgical procedures and shunting. However, the long-term results are still a matter of interest. *Patients and methods:* We analysed our prospective data from 20 patients (male:12, female:8) with symptomatic arachnoid cysts treated with neuroendoscopy. The average age of the patients was 13.5 years. Fifteen cysts were located in the middle fossa, two in the posterior fossa and three in the suprasellar area. One child showed an associated hydrocephalus. The patients' symptoms included headache, seizures, nausea, dizziness, gait disturbances, and precocious puberty. The techniques performed were studied and reoperations were noticed. The cyst size was evaluated with MR images or CT scans during follow up. *Results:* Three ventriculocystostomies, 14 cystocisternostomies, and three ventriculo-cysto-cisternostomies were performed. Additionally, in eight patients a stent was inserted. Neuronavigation was used in seven procedures. In one case the endoscopic procedure had to be abandoned due to a bleeding. The mean follow up was 36.9 months (range 10-86 months). Three re-cystostomies had to be done after 15, 24, and 41 months respectively because of recurrent symptoms. In the child with the associated hydrocephalus, a shunt was implanted after 14 months, despite a significant cyst reduction. The follow-up MR images or CT scans showed a cyst reduction in 15 patients. In five patients the cyst size remained unchanged. The clinical symptoms resolved or improved in 16 patients. In four patients who presented with minor and unspecific symptoms, the complaints were unchanged. *Conclusion:* Neuroendoscopic fenestration of arachnoid cysts has proven to be successful and effective even in long-term. Using endoscopic techniques, craniotomies and shunts can often be avoided.

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Endoscopic treatment of suprasellar arachnoid cysts. J. Krauss, N. Sörensen (Würzburg)

Patients and methods: We report on a series of 24 patients, consecutively treated between 1996 and March 2005. Data of the surgical procedures were collected prospectively. Hydrocephalus was assessed clinically and on preoperative MRI and routinely controlled with MRI after 3 months and after one year. Follow-up ranges from one to seven years. 21 children (under 16 years of age) with an average age of 4 years and 7 months and 3 adolescent/adult patients were treated. Obstructive hydrocephalus was present in all but one patient. The most common symptoms were signs of elevated intracranial pressure in 12, endocrine abnormalities in 9 and psychomotoric retardation in 5. All patients were treated with fenestration of the apical and basal cyst walls (cysto-ventriculo-cisternostomy). *Results:* Complications occurred in one case with ventriculitis and one transient oculomotor nerve paresis. Hyponatremia if present preoperatively tended to temporarily worsen. There was no permanent morbidity or mortality. 21 of 24 patients remained shunt-free during follow-up. Psychomotor retardation may improve, whereas endocrine abnormalities and visual impairment remained unchanged. *Conclusion:* As experience ac-

cumulating, neuroendoscopy establish its status as treatment modality of choice for these lesions.

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“Intraventricular” arachnoid cysts. C. E. Deopujari, R. Shah, R. Luhana, V. Karmarkar, C. Bhalke (Mumbai)

Objective: Intraventricular arachnoid cyst is a rare but well-defined entity, which usually presents with a hydrocephalic syndrome. Shunt insertion may be difficult and is usually not sufficient. *Patients and methods:* In the last 5 years, we have treated 5 children with anterior 3rd ventricular, 2 children with posterior 3rd ventricular and 2 children with lateral ventricular arachnoid cysts. Endoscopic fenestration was performed in all cases. Previous attempts at shunt insertion were unsuccessful in 3 cases. In intraventricular arachnoid cysts the cyst wall has to be fenestrated into the ventricular system, but also into the basal cisterns to establish a restoration of normal CSF pathways. As an alternative suprasellar arachnoid cysts can also be tackled transsphenoidally. In contrast to children, in adults they typically cause visual symptoms and are not associated with hydrocephalus. 2 patients of our collective were treated using the endonasal transsphenoidal approach. *Results:* All patients had a good outcome. As the cyst takes time to collapse, imaging can be in contrast to the improvement of patients' symptoms.

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Endoscopic treatment of suprasellar arachnoid cysts. Y. Ersahin, H. Kesikçi, T. Yurtseven, C. Aydin, S. Mutluer (Izmir)

Objectives: Arachnoid cysts are intra-arachnoid collections of cerebrospinal fluid (CSF) that produce neurological symptoms either by compressing neuronal tissue or by obstructing CSF pathways. Arachnoid cysts constitute 1% of all intracranial space occupying lesions not resulting from trauma. Arachnoid cysts can arise in any part of the central nervous system where arachnoid tissue is found. However, suprasellar arachnoid cysts are uncommon. Obstructive hydrocephalus is the most common cause of initial symptoms and occurs in almost 90% of the patients with suprasellar arachnoid cysts. *Patients and methods:* We report on 11 patients with suprasellar arachnoid cysts who were treated using neuroendoscopic techniques. The patients ranged from 7 months to 17 years of age (median 65.3 months), with 5 males and 6 females. All infants (4 patients) presented with macrocephalus and noncommunicating hydrocephalus. One of the patients suffered from precocious puberty. Endoscopic ventriculo-cystostomy and/or cysto-cisternostomy has been performed in all patients. Only one patient with a gigantic suprasellar arachnoid cyst needed a shunt insertion. Ankara Developmental Screening Inventory and Wechsler Intelligence Scale for Children-Revised tests were administered postoperatively in the patients younger and older than 6 years, respectively. Patients with suprasellar arachnoid cysts diagnosed in infancy were found slightly mentally retarded. *Conclusions:* Today neuroendoscopic treatment of suprasellar arachnoid cysts is effective and less invasive than other treatment modalities.

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Neuroendoscopic treatment of arachnoid cysts of the quadrigeminal cistern: report of thirteen cases. L. Columbano, C. Spennato, C. Ruggiero, L. Cuomo, C. Sainte-Rose*, E. Cianciulli, G. Cinalli (Naples, Paris*)

Objectives: To evaluate the role of neuroendoscopy in the treatment of arachnoid of the quadrigeminal cistern. *Patients and methods:* Thirteen patients affected by arachnoid cysts of the quadrigeminal cistern were treated endoscopically between March 1995 and February 2005. Five were treated at the Hôpital Necker-

Enfants Malades in Paris (France) and eight at the Santobono Children's Hospital in Naples (Italy). Nine patients underwent an endoscopic procedure as a primary treatment and four as an alternative to shunt revision. In 6 cases the first endoscopic procedure performed was ventriculocystostomy associated with third ventriculostomy. Only one of them was re-operated for subdural hygroma by application of a subduro-peritoneal shunt. In 7 cases the first endoscopic procedure performed was ventriculocystostomy, without third ventriculostomy. All of them were re-operated: four endoscopically 2, 4 and 5 months respectively with final success in all cases. Three of them had shunt implant or shunt revision. **Conclusion:** The analysis of this small series seems to suggest that arachnoid cysts of the quadrigeminal cistern and the associated hydrocephalus can be treated by endoscopy; this approach leaves the patient shunt independent in more than 75% of the cases. Third ventriculostomy should be associated to the ventriculocystostomy to offer the highest success rate with a single procedure.

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Neuroendoscopic approach to intracranial cysts. I. Anik, V. Etus, K. Koc, S. Ceylan (Kocaeli)

Objectives: The purpose of this study is to evaluate the efficacy of the neuroendoscopic approach to intracranial cysts. **Patients and methods:** We present a retrospective evaluation of data from 15 patients who underwent neuroendoscopic surgery for intracranial cysts between 1998 to 2004. The present series included intraventricular arachnoid cysts, intraventricular ependymal cysts, suprasellar arachnoid cysts, arachnoidal loculations in the lateral ventricles, isolated ventricles and colloid cysts. The cysts were diagnosed preoperatively and followed-up postoperatively by MRI studies. **Conclusion:** Arachnoid cysts, colloid cysts, intraventricular cysts, ependymal cysts are benign intracranial lesions. As they all have a common benign clinical course their treatment should be minimally invasive. Endoscopic techniques are thought to be the best choice in minimizing surgical traumatization. Hydrocephalus, focal neurological deficit, progressive symptoms like seizures, and space occupation are some of the indications for the treatment of intracranial cystic lesions. The neuroendoscopic approach is a minimally invasive method and also gives the chance to perform third ventriculostomy or aqueductoplasty for obstructive hydrocephalus at the same time. It also increases shunt effects by opening septations in the cystic lesions.

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Endoscopic management of supratentorial intra- and paraventricular cysts. G. Tamburrini, C. Di Rocco, M. Caldarelli, L. Massimi (Rome)

Objective: Neuroendoscopic fenestration is actually considered the treatment of choice in patients with intraventricular and paraventricular cysts. However, controversies still exist on the need to combine or not ventriculocystostomy with ventriculo- or cysto-cisternostomy and how to manage children with associated hydrocephalus. **Patients and methods:** From March 2002 to June 2004 we endoscopically treated (rigid Storz endoscope) 21 patients (M/F = 16/5, mean age = 4.9 years) with supratentorial intra- or paraventricular cysts. Patient population consisted of ten children with intraventricular quadrigeminal plate arachnoid cysts; six patients with secondary intraventricular cysts in previously shunted hydrocephalus; four children with paraventricular arachnoid cysts and one with a choroid plexus cyst. Cyst marsupialization was the only treatment in thirteen patients; a third ventriculostomy (four cases) were contemporarily performed in eight children. **Results:** Surgical complications were represented by one case (6.6%) of CSF leakage from the surgical wound. Recurrence of the cystic lesion was observed in two patients (13.3%), who both underwent a second neuroendoscopic cyst marsupialization. 92.3% of the pa-

tients showed a complete resolution of preoperative clinical signs; in one patient only a partly improvement could be reached. Control MRI examination (mean follow up: 15.3 months) showed a significant reduction of the cyst volume in 19 cases and a decompressive effect on the cyst wall in two patients. **Conclusions:** Our results confirm that neuroendoscopy should be the technique of choice in children with intraventricular and paraventricular cysts. Ventriculo-cisternostomy or shunt revision should be considered only in children with associated hydrocephalus.

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Neuroendoscopy in children with interhemispheric cysts and hydrocephalus. L. Savarese, P. Spennato, C. Ruggiero, F. Aliberti, E. Cianciulli, G. Cinalli (Naples)

Objective: Interhemispheric arachnoid cysts are rare and often associated with complex children's malformations such as corpus callosum agenesis and hydrocephalus. Shunting and microsurgical marsupialization of the cyst are the traditional treatment options. We evaluate retrospectively the effectiveness of endoscopic treatment as an alternative to shunting and microsurgery. **Patients and methods:** Between 2001-2004 five consecutive pediatric patients affected by interhemispheric arachnoid cysts underwent neuroendoscopic treatment by the means of cysto-ventriculostomy (1 case), cysto-cisternostomy (1 case), and cysto-ventriculo-cisternostomy (3 cases). Associated hydrocephalus was present in all patients, corpus callosum agenesis in 5 cases, and corpus callosum hypogenesis in 1 case. **Results:** The follow-up period ranged from 2 to 44 months (mean 19.5 months). Endoscopic procedures were successful in all cases. One patient presented re-expansion of the cyst for stoma closure and was re-operated endoscopically 9 months after the first procedure. Subdural CSF collection required insertion of a subduro-peritoneal shunt in 1 patient. Neurological and developmental outcome was good except for two patients, who showed developmental delay. **Conclusions:** Endoscopic treatment of interhemispheric cysts can be considered a useful alternative to traditional treatment, even if some complications, such as subdural or subcutaneous CSF collections and CSF leaks, due to the lack of cerebral mantle have to be expected.

16 June, Thursday: 16.15–18.00

Session 5

Neuroendoscopy and cystic lesions II

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Cooperative study of the Italian Neuroendoscopy Group on the treatment of 61 colloid cysts. P.L. Longatti*, U. Godano, M. Gangemi, A. Delitalia, E. Morace, L. Genitori, C. Alafaci, L. Benvenuti, A. Brunori, C. Cereda, S. Cipri, A. Fiorindi, F. Giordano, C. Mascari, P.A. Oppido, A. Perin, M. Tripodi (Treviso*, Bologna, Brescia, Brindisi, Firenze, Livorno, Messina, Napoli, Padova, Reggio Calabria, Rome)

Objective: Colloid cysts of the third ventricle account for 0.5% of intracranial lesions. Microsurgical resection, stereotactic aspiration and VP shunt application have been for years the first choice options for their treatment. Recently, endoscopic approaches have gained increasing interest and acceptance. Relatively long-term results are now available and some conclusions could be inferred on the efficacy of this procedure. **Patients and methods:** Between August 1995 and December 2004, 61 patients harbouring a symptomatic colloid cyst of the third ventricle, were treated using neu-

roendoscopic technique in 11 Italian neurosurgical centers. Cyst diameter ranged from 6 to 32 mm. A flexible endoscope was used in 34 cases, a rigid one in 21, both in 6. Mean operating time was 87 minutes. Operative technique included cyst fenestration, aspiration of the contents, coagulation of the cyst wall and occasionally capsule excision. *Results:* Mean post-operative hospital stay was 7.2 days. The technique was always effective in restoring CSF circulation. Early post-operative imaging revealed cyst remnants in 36 cases. (mean diameter 4.3 mm). There were four complications (6.5%). Follow-up varied between 1 to 132 months (mean 32 months, more than five years in 15 patients). There were 5 asymptomatic recurrences, all but one evolving from residues. *Conclusion:* The endoscopic approach to the treatment of colloid cysts is safe, effective and well accepted. Recurrence rates (8.1%) even though asymptomatic, cast a persisting shadow on the long-term results, and therefore the controversy with the traditional microsurgical treatment is far from a clear-cut definition.

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Neuroendoscopic treatment of cystic thalamic and mid-brain lesions. M. Cartmill, M. Tsegaye, M. Vloeberghs (Nottingham)

Patients and methods: Five cases where lesions in the midbrain with a large cystic component causing hydrocephalus are presented. The age range of the patients was 4-13 years, 2 were male and 3 female. All presented with symptoms of raised intracranial pressure as a dominant sign and secondary endocrine disorders. Preoperative work up consisted of complete endocrine blood tests and MRI with CISS sequence. The lesions, 3 hypothalamic gliomas and 2 craniopharyngiomas, were symptomatic because of the cystic component causing hydrocephalus and not because of their solid component. Resection of the solid component would have been possible but not without significant morbidity or mortality. The endoscopic approach was preferred. Using a flexible or hybrid neuroendoscope it was possible to marsupialise the cystic component of the tumour, perform a biopsy where necessary and relieve the hydrocephalus. *Results:* There was no morbidity associated to the endoscopy. Further treatment was then offered based on the histology of the lesion. *Conclusion:* This review shows the potential of the neuroendoscopic approach to deep-seated lesions in the thalamus or mid-brain. The minimally invasive technique lives up to its reputation causing little or no morbidity in these difficult cases.

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Hydrocephalus and intracranial CSF cysts: the role of endoscopic treatment. Experience in 22 cases. U. Godano, C. Mascari, E. Galassi, M. Zucchelli (Bologna)

Objective: The association of hydrocephalus and CSF cysts represents a particularly difficult problem because either the fenestration of the cyst may be unsuccessful or, even if the cyst decreases in size, the hydrocephalus may remain unchanged. The aim of this paper is to analyze the role of endoscopic technique in the treatment of such pathology in order to determine the advantages of endoscopy compared to conventional fenestration and shunting procedures. *Patients and methods:* We operated on endoscopically 22 cases of intracranial CSF cysts associated with hydrocephalus (10 males and 12 females, aged between 6 months and 68 years). Cyst location was suprasellar in 6 cases, infratentorial in 5 cases, quadrigeminal in 4 cases, endo-paraventricular in 7 cases. We adapted the technique of pure endoscopy in all cases except one, which was treated by endoscope-assisted microsurgery. *Results:* In 14 cases the endoscopic procedure alone was successful in treating both the cyst and the hydrocephalus. A shunting procedure was necessary in the other 8 cases (a ventriculo-peritoneal shunt in 7 cases, in which the endoscopic treatment of hydrocephalus failed and a cysto-peritoneal shunt in 1 case of failure). *Conclusions:* This series shows, that endoscopic treatment can effect the resolu-

tion of both, hydrocephalus and intracranial cysts in more than 60% of the cases, with the great advantage of a minimally invasive approach. In those cases, where the endoscopic treatment is unsuccessful a ventriculo-peritoneal shunt allows the resolution of the hydrocephalus and the evacuation of the cyst through the previous endoscopic fenestration.

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Endoscopic treatment of eight symptomatic deep midline cysts in adults. A. Bussarsky, R. Karakostov, V. Popov, V. Bussarsky, P. Genov (Sofia)

Objective: Symptomatic midline cysts are rare in adults. There is still controversy about their best endoscopic management. The authors present their experience and discuss options using the endoscopic approach. *Patients and Methods:* 8 patients (4 men and 4 women) with deep-seated midline cysts were treated endoscopically between 2001 and 2004. They included 5 cavi septi pellucidi, 2 cavi vergae and 1 cavum veli interpositi. Presented symptoms were intermittent headache (100%), vertigo (50%), gait instability (37.5%), vegetative symptoms (62.5%), mental changes (37.5%). Endoscopic treatment (unilateral or bilateral pellucidotomy, cystostomy) was performed with a rigid endoscope via a precoronal burr hole approach. Neuronavigation was used in 2 cases. *Results:* There was no postoperative morbidity or mortality. Intraoperative problems included three initial misplacements of the endoscope, one disorientation, and one ependymal contusion. Headache, vertigo and vegetative symptoms were resolved in all cases, mental and gait disturbances improved in 2 of 3 patients. Postoperative imaging studies confirmed reduction of cyst size and communication with the CSF spaces. *Conclusion:* Neuroendoscopy is a safe treatment modality for symptomatic midline cysts. Symptoms related to raised ICP respond best. Careful planning of the operative approach using neuronavigation is essential to avoid complications. Alternative approaches via the occipital horn should be considered.

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Neuroendoscopic treatment of enlarged perivascular spaces mimicking multicystic brain tumors. D.M. Schulte, J. Rohlf, T. Riegel, H.D. Mennel, H. Bertalanffy, D. Hellwig (Marburg)

Objective: The incidence of enlarged Virchow-Robin spaces appearing as huge cystic lesions is extremely rare. These perivascular spaces are extensions of the pia mater accompanying perforating arteries and can invade the periventricular white matter. Prominent dilation can cause obstructive hydrocephalus and mimic brain tumors requiring neurosurgical intervention. *Method and patients:* Two cases of extremely dilated Virchow-Robin spaces located in the basal ganglia and thalamo-mesencephalic region were treated by neuroendoscopic cysto-cisternostomy respectively ventriculocystostomy. A biopsy of the membranes was taken and histopathologically analysed. The outcome of the patients was followed and review of the literature was performed. *Results:* The expanding nature of this variety is demonstrated by the progressive clinical course due to compressive effect on the adjacent brain parenchyma and obstructive hydrocephalus. The patients were successfully treated by a neuroendoscopic approach. It minimized the operative risk, verified histopathological diagnosis and led to an excellent clinical outcome with improvement of the neurological symptoms. The reduced space occupying effect could be documented radiologically. Only two previously published papers report such expanding Virchow-Robin spaces with compressive effect which were directly fenestrated by neuroendoscopic techniques. *Conclusion:* The rare diagnosis of dilated Virchow-Robin spaces should be kept in mind as differential diagnosis of multicystic lesions suspicious of brain tumors. Neuroendoscopic surgery including cysto-cisternostomy or ventriculocystostomy can

be an effective and low risk treatment option for these cystic varieties with compressive effect and consecutive hydrocephalus.

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Alternative treatment of cystic craniopharyngioma. M. Vloeberghs (Nottingham)

Objective: Craniopharyngioma has been described as “benign tumour in a malignant position”. Enlargement of the tumour causes compression of the optic chiasm, pituitary and hypothalamus, leading to progressive blindness, hypopituitarism and hypothalamic syndrome. Frequently the progression accelerates dramatically when the tumour produces a rapidly enlarging cyst. Traditionally the treatment has been an attempt to completely excise it, often with grossly debilitating effects, and may cause failure as a high proportion of tumours recur. More recently cystic tumours have been treated by stereotactic cyst aspiration with or without the placement of an Ommaya reservoir to enable re-aspiration when the cyst recurs. We present a series of six cases of cystic craniopharyngioma treated with a new technique: neuroendoscopic marsupialisation. *Material and methods:* Five patients with cystic craniopharyngioma were treated. Each was assessed endocrinologically, ophthalmologically, and radiologically pre- and postoperatively. The endoscope was inserted into the right lateral ventricle and then passed through the foramen on Monro into the third ventricle. The cyst was located by pulsing lavage fluid against the third ventricular wall. A wide opening was made in the septum between cyst and ventricle using a diathermy probe. If necessary, the cyst was entered and loculi were opened in similar fashion. Follow-up was 5-53 months (mean 22 months). All patients underwent radiotherapy. *Results:* All patients showed an improvement in visual status. The procedure was tolerated well and there were no major complications. There were no great endocrine unbalances after the procedure. One patient required a further procedure within the follow-up period. *Conclusion:* Neuroendoscopic marsupialization appears to be a safe and effective method of decompressing craniopharyngioma cysts.

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Endoscopic treatment of cystic craniopharyngioma. M.M. Mariano, C.L.Y. Tan, C.G. Barredo (Quezon City)

Objective: The surgical treatment of predominantly cystic craniopharyngioma still represents a formidable challenge despite the advances in microsurgery and stereotactic surgery. While total microsurgical resection is still the gold standard, alternative minimally invasive procedures aiming at immediate relief of mass effect and obstructive hydrocephalus may be a valuable surgical option in some selected cases. *Patients and methods:* The author treated 15 patients with the predominantly cystic craniopharyngioma with obstructive hydrocephalus by endoscopic coronal transventricular-transforaminal approach. The cyst wall was punctured using a silastic catheter and the contents are completely drained. Care is undertaken to prevent spillage of the cyst contents into the ventricular system. An Ommaya reservoir was connected to the catheter and embedded in the subgaleal space. No ventriculo-peritoneal shunts were inserted in any patients. Postoperative radiotherapy or radiosurgery was given to all patients. *Results:* Clinical and imaging follow-up (range from 48 to 6 months) is very encouraging since all patients showed excellent results. None of them needed a CSF diversion procedure. *Conclusion:* Whenever surgical difficulties are to be anticipated in the management of cystic craniopharyngioma, the endoscopic treatment should be considered as a valuable surgical alternative option in this pathology.

17 June, Friday: 08.00–09.30

Session 6

Neuroendoscopy and brain tumours

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The International Neuro-Endoscopic Biopsy Study (INEBS): an ISGNE retrospective survey. S. Constantini, S. Sgouros, D. Hellwig, I. Veshchev, R. Abbott (Tel Aviv, Birmingham, Marburg, N.Y.)

Objective: Although Neuro-Endoscopic biopsies (NEB) are routinely performed, the safety and validity of NEB has been studied only for a small number of patients in single centre reports. The aim of this study is to collect data on large numbers of NEB patients retrospectively at several international centres known to perform neuro-endoscopic procedures on a regular basis. *Material and Methods:* Retrospective data-collection from 13 centres routinely performing NEB over a period of 5 years. The essential patient data focused on all biopsy attempts. Feedback from the neuropathologist on the study form was essential. *Results:* We received 292 patient data forms from 13 medical centres in 9 countries. Patients' age ranged from 0.1 to 78.7 years (median 20.4). Tumor location was pineal (34%), thalamic (18%), intraventricular (21%), tectal (12%), hypothalamic (55) and other locations (10%). Tumor size was <10 mm (13%), 10-20 mm (36%), and 20 mm (50%). In addition to the NEB, 59 had endoscopic third ventriculostomy (ETV) and 14% septum pellucidotomy. There was one intraoperative death reported, due to massive haemorrhage. 80% had a mild bleeding during the procedure, 14% moderate, and 6% severe. Infection occurred in 3%, and other complications, mostly reversible, in 11%. Tumor types ranged across the spectrum, including astrocytoma (low-grade-32%, high-grade-13%), germinoma (11%), PNET (11%), non-neoplastic (5%), and other tumour types (18%). 105 had non-conclusive pathology. *Conclusion:* This is the largest series looking at the safety and validity of NEB. NEB had a relatively low, and mostly reversible, complication rate of below 13%. Neuro-endoscopic biopsy provided meaningful pathological data for 90% of the patients.

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Neuroendoscopic procedures in brain tumour therapy. P.A. Oppido, F. Cattani, C. Carapella, E. Occhipinti, E. Morace (Rome)

Objective: Neuroendoscopy is presently considered a scarcely invasive surgical approach to expanding lesions bulging into the ventricles, and a relevant tool to perform bioptic procedures, fenestration of cystic walls, or tumour removal in selected cases. Furthermore, the advances in neuro-imaging techniques, and the accurate follow-up of brain tumour patients have more frequently allowed demonstrating the presence of tumoural and pseudo-tumoural cystic areas, causing the obstruction of cerebrospinal fluid pathways. Neuroendoscopic procedures enable fenestration of cystic lesions, in addition to third ventriculostomy, or septostomy. *Patients and methods:* We analyse our experience regarding 21 patient suffering from brain tumours: 9 gliomas, 2 metastases, 3 dysembryogenic lesions, 1 pineal tumour, 1 van Recklinghausen disease, 5 colloid cysts. Advantages and limits, comparing flexible versus rigid endoscopes are reviewed. In all cases the hydrocephalus and/or obstruction of CSF pathways were present. 26 neuroendoscopic procedures were performed. *Results:* In 6 para/intraventricular tumours serial biopsies were obtained, followed by 1 case of postoperative haemorrhage, but no CSF leakage. In addition, third ventriculostomy was performed in 11 patients with non-communicating hydrocephalus. In 4 cases fenestration of postoperative

tumour cysts, and marsupialization into the ventricle solved a relevant mass effect with intracranial hypertension syndrome. In 11 patients reopening of the CSF pathways to treat intracranial hypertension, allowed to continue tumour adjuvant therapy, and meaningfully improve patients' quality of life. In 5 cases colloid cyst removal using the rigid endoscope was possible. *Conclusion:* In this series neuroendoscopy was found to be a safe and effective procedure, avoiding major surgical approaches and was without postoperative morbidity. Based on these results, as well as on the increasing series presented in literature, the authors suggest, that neuroendoscopic techniques should be considered a selected approach to para- or intraventricular tumours, not limited to relief of non-communicating hydrocephalus, but also useful for tumour biopsy or removal, and evacuation of cystic lesions.

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Endoscopic surgery of third ventricular lesions. Z. Novak J. Chrastina, I. Riha, E. Lzicarova, P. Krupa (Brno)

Objective: Apuzzo's monography provides an excellent overview of microsurgical interventions for third ventricular lesions. Neuroendoscopy adds more safety and precision, especially when combined with stereotaxy or neuronavigation. The aim of this study is to present experience with endoscopic treatment of third ventricular pathologies. *Patients and methods:* 26 patients (12m, 14f, mean age: 45.2 years) were operated on to re-establish CSF pathways, histological evaluation and safe removal or debulking. Pathological investigations revealed colloid cyst in 5 patients and glial cysts in another 5. Malignancy was diagnosed in 6 cases (metastases, PNET, malignant glioma, pineoblastoma). Outcome was excellent in 15 patients (57.4%), mainly transient minor deficits occurred in 7 patients (26.8%, favourable outcome 84.2%). Adverse outcomes were present in 4 patients with malignancies due to tumour biology. Palliation of intracranial hypertension with bioptic verification of histopathological diagnosis was the indication for surgery. *Discussion:* The choice of surgical trajectory is based on multimodal planning (MRI, MR-angiography, CT). Data transmitted via PACS are processed in the neurosurgical workstation. The trajectory should be planned with respect to arteries, venous vessels draining vital structures and neural pathways (fornix). Regarding the localisation of the lesion, the third ventricle consists of an anterior, middle and posterior part. Lesions in the anterior portion are less frequent. The importance of the meticulous technique – bipolar coagulation, septostomy, ETV should be underlined. *Conclusion:* The safety of neuroendoscopic interventions in third ventricular lesions is mainly enhanced by neuronavigational or stereotactic guidance. Navigation should not only plan the optimal trajectory to the lesion, but also respect vital vascular (draining veins) and neural structures (fornices, mamillary bodies).

41

Perioperative quality of life assessment in endoscopically treated patients with pineal region tumours. T. Riegel, W. Tirakotai, A. Stiegel, M. Koller, S. Heinze, D. Hellwig, H. Bertalanffy, I. Celik (Marburg)

Objective: Therapeutic modalities for pineal region tumours are still under discussion. Endoscopic treatment can be considered as a minimally invasive approach. Aim of this study was to assess the quality of life of patients with pineal region tumours underwent endoscopic procedures. *Patients and methods:* Eight patients (male:3, female:5) were included in this study. Postoperative evaluation of surgical outcome in terms of quality of life (QL) was performed using the Quality of Life Questionnaire (QLQ-C30). Patient's outcome scores were compared with German population nominative outcome values. Pre- and postoperative global QL and symptoms like headache, visual disturbance, gait disturbance, cog-

nitive function and unconsciousness were documented. Descriptive and explorative statistics were performed. *Results:* According to our questionnaire analysis, there were no significant differences between German population and the endoscopically treated patients in terms of various functions (physical functioning 87.5%, emotional functioning 50%, cognitive functioning 50%, social functioning 62.5%, percentage represents regular functioning). Improved quality of life could be demonstrated in short (3-12 months, n=3) and long-term (21-29 months, n=5) follow-up. Global QL improved significantly ($p < 0.001$; t-test) postoperatively. The following preoperative clinical symptoms could be demonstrated (headache 87.5%, visual disturbance 50%, gait disturbance 87.5%, cognitive functioning 75%, unconsciousness 25%). The remaining postoperative symptoms were revealed in terms of percentage (headache 62.5%, visual disturbance 25%, gait disturbance 25, cognitive functioning 37.5%). *Conclusion:* Endoscopic treatment in patients with pineal region tumours exhibit improved postoperative quality of life in all health domains. Therefore, we would consider the endoscopic approach as an alternative treatment in patients with unclarified pineal tumours entity and/or related hydrocephalus.

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The role of endoscopy in the management of brain tumours. M. Jalaluddin, M. Hassounah, E Alshail, I. Kannan (Riyadh)

Objective: Many patients with brain tumors in the pineal region, tectum, thalamus and paraventricular area can be managed with low morbidity and mortality. We present our experiences in management of brain tumours using neuroendoscopic techniques. *Patients and methods:* From January 1996 to February 2005 49 patients suffering brain tumours were treated by endoscopic procedures. *Results:* There was no operative morbidity or mortality. Tumor bioptic procedures were successful in 22 from 23. The average duration of surgery was 50 minutes. Total costs involved were 1/2 to 1/3 as compared to standard surgical procedures. *Conclusions:* We conclude that neuroendoscopic procedures are safe and cost effective in the management of brain tumours.

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The role of neuroendoscopy in the management of solid intraventricular/periventricular tumours. W. Tirakotai, D. Hellwig, D.M. Schulte H. Bertalanffy, D, T. Riegel (Marburg)

Objective: The purpose of this study was to describe the surgical strategies of neuroendoscopic treatment in patients with solid intra-, periventricular tumours. *Patients and methods:* From 1990 to 2004, forty-eight patients with unclarified peri- and intraventricular tumours underwent neuroendoscopic procedures, including hydrocephalus treatment, tumour biopsy or tumour resection. Since 1997 neuronavigation has been applied to selected cases. *Results:* Histopathological diagnosis could be established in all patients. Obstructive hydrocephalus was treated sufficiently by endoscopic third ventriculostomy or endoscopic stent placement. Partial or total extirpation of solid tumor was achieved in four cases. Histopathological diagnosis revealed astrocytomas in 19 cases, craniopharyngioma in 6 cases, and ependymoma and germinoma in 5 patients respectively. Subsequent mode of treatment such as chemotherapy, radiation therapy or microscopic surgery was determined according to the histopathological findings. There were three transient morbidities and one permanent deficit, but there was no operative mortality. *Conclusion:* The transventricular endoscopic approach with or without navigational guidance is an effective and reliable alternative treatment of unclarified peri- and intraventricular lesions. Neuroendoscopic procedures offer the opportunity to combine tumour biopsy and treatment of hydrocephalus. Endoscopic techniques can also be combined with microsurgical approaches according to the tumour location or the

histopathological results. In selected patients, partial or total removal could be performed.

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Neuroendoscopic treatment of intracranial lipomas. Z. Novak J. Chrastina, I. Riha (Brno)

Objective: Lipomas are rare intracranial expansions with predominance for midline structures. They are discovered incidentally during evaluation for non specific problems. The aim of the paper is to present three cases of patients with intracranial lipomas who underwent endoscopic surgery for this symptomatic lesion. *Case descriptions:* 20 years old girl was admitted with increasing headache and visual problems. MRI revealed a lipoma located in the quadrigeminal cistern with brainstem compression and ventricular dilatation. ETV under stereotactic navigation resolved the problems. Another 19 years old male, underwent exploration of suspected corpus callosum cyst via craniotomy 10 years before. Worsening of seizures led to MRI evaluation and endoscopic operation (biopsy and foramen Monroi decompression) with good outcome regarding both seizures and headaches. The third patient was referred for neurosurgical evaluation of repeated confusional behaviour with bursts of aggressiveness. MRI examination showed a small lipoma beneath the floor of the third ventricle with moderate ventricular dilatation. Due to the localisation of the lesion next to the mamillary bodies the lesion was removed in neuroendoscopic technique with postoperative resolution of the psychiatric problems. *Discussion and conclusion:* Surgical decision-making requires detailed analysis and correlation of clinical, radiological and laboratory data. Functional correlation with stereotactic data is important especially in lesions related to vital hypothalamic structures. Symptoms of raised ICP indicate surgery and can be resolved by neuroendoscopic intervention.

17 June, Friday: 09.45–11.30

Session 7

Neuroendoscopic pituitary surgery

45

The extended endoscopic endonasal approach to the clivus and cranio-cervical junction. Anatomical study. L.M. Cavallo, P. Cappabianca, A. Messina, F. Esposito, E. de Divitiis, M. Tschabitscher* (Naples, Vienna*)

Objective: Lesions located in the retroclival area and at the level of the cranio-cervical junctions are typically approached through a variety of antero-lateral, lateral and postero-lateral skull-base approaches, either alone or in combination as "staged approaches". *Material and methods:* To assess the feasibility of the endonasal transclival route for the surgical management of lesions these regions offer, 5 injected fresh cadaver heads have been dissected using a modified endoscopic endonasal approach. Access to the clivus was possible using a lower trajectory when compared to that necessary for the sellar region. The sphenoid sinus is entered and the posterior wall of the sphenoid sinus together with the visible part of the clivus are removed. The rhinopharyngeal portion of the clivus can be exposed by means of a midline incision of the mucosa of the rhinopharynx, extending downwards to the level of the Eustachian tube. A full access to the anterolateral brainstem and the cisternal space around it is possible with this approach after the incision of the dura, from the interpeduncular cistern to the spinomedullary junction, including a thorough vision of the verte-

brobasilar arterial system and of Cranial Nerves II to XII. The major potential advantage route to the epicentre of the lesion since it does not tranverse any major neurovascular structures, thereby obviating brain retraction. The potential disadvantages include the relatively restricted exposure and the danger of an inadequate dural repair with resultant CSF leak or meningitis.

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Endoscopic endonasal approach to the cavernous sinus. G. Frank, E. Pasquini, D. Mazzatenta, F. Foglietto (Bologna)

Objective: The anterior approach to the cavernous sinus, with respect to the craniotomic route, is more rapid, direct and extracerebral. Transsphenoidal microsurgery is used principally for pituitary adenomas, but consents a limited lateral vision of the operative field. Faioli and col. (1993) tried to overcome this drawback proposing a transmaxillary transsphenoidal route for adenomas invading the medial compartment of the cavernous sinus. The experience acquired with the endoscopic transsphenoidal surgery in pituitary adenomas has led us to extend the indications to tumours invading both the medial and the lateral compartment of the cavernous sinus. Endoscopy, with respect to microscope, inverts the cone of vision of the operative field and the use of angled optics permits a good vision of the entire sphenoidal sinus, even of the lateral recesses. In the approach to the cavernous sinus we propose to utilize an endoscopic technique and a transethmoidal-transsphenoidal route, extended laterally, in the case of wide lateral pneumatization of the sphenoidal sinus, removing the pterygoid process and clamping of the sphenopalatine artery. This route guarantees a wide, direct and minimally invasive approach both to the medial and to the lateral compartment of the cavernous sinus. During the opening of the dura and during the tumoral debulking we use the neuronavigator and a 16 Hz probe, 1 mm in diameter, to localize the carotid artery. Since May 1998 we have used the endoscopic endonasal approach and the Ethmoido-Pterygoidal-Sphenoidal (EPS) approach in 65 pituitary adenomas invading the cavernous sinus. Results are presented and discussed. *Conclusion:* We stress the opportunity of operating adenomas with an involvement of cavernous sinus even when most surgeons suggest a non aggressive and favour radiotherapy or radiosurgery.

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Experience with the endoscopic transsphenoidal approach. C.E. Deopujari, N. Shah, R. Shah, U. Andar, V. Karmarkar, R. Luhana, C. Bhalke (Mumbai)

Objectives: The endonasal endoscopic approach to trans-sphenoidal surgery is an extension of the classic approach, facilitating entry into corners of the sella and into the suprasellar compartments. This not only facilitates more complete tumour removal but also ensures safety by avoiding injury. Post-operative nasal and PNS complications are virtually eliminated by the endonasal technique. *Patients and methods:* Experience with 228 cases operated by this approach over the last eight years is presented, to illustrate the technical variations, which have allowed us to obtain good results. These included 207 pituitary tumours and 21 other lesions including craniopharyngiomas, chordomas, Rathke's cleft cysts and inflammatory lesions.

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Endoscopic pituitary surgery: an early and late experience. K. Koc, I. Anik, B. Cabuk, S. Ceylan (Kocaeli)

Objective: Recently many neurosurgeons involved in pituitary neurosurgery using an endoscope to visualize hidden anatomical corners as supplementary visualizing tools during microsurgical transsphenoidal pituitary surgery. Furthermore pituitary surgery

can be performed completely endoscopically without using a nasal speculum or retractor. We report upon our early and late experiences of pure endoscopic transsphenoidal surgery. *Patients and methods:* From 1997 to 2005 68 patients with pituitary adenomas were operated on in pure neuroendoscopic transsphenoidal technique without using a nasal speculum or a retractor. In a retrospective study we evaluated the operative technique considering the excision of the turbinate, diameter of sphenotomy, localisation of sellar opening, the importance of the sphenoid septum, the use of the endoscope holder and the application of fibrin glue. *Results:* Although in the first five patients endoscopic surgery was planned and started in endoscopical technique it was finished microsurgically because of lack of experience and patients' features. The resection of the turbinate and the use of a holder was applied in the first cases. After gaining experience we performed hemisphenoidotomy in some of the patients with microadenoma to protect the sphenoid septum. The extended parasellar approach was performed for the medial wall of the cavernous sinus. *Conclusion:* Endoscopic transsphenoidal surgery is minimal invasive surgery. Nasal, sphenoidal, and sellar steps of the approach can be planned preoperatively and can be modified intraoperatively according to actual endoscopic visualization.

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Endoscopic treatment of pituitary adenomas without and with the Brainsuite®. E.R. Orlando, G. Trillo, L. Ferrante (Rome)

Patients and methods: Since June 2002, 68 patients with pituitary adenomas (56 macroadenomas, 12 microadenomas) have been treated in our department. 27 of these patients (23 macro- and 4 microadenomas) have been operated in the Brainsuite® since September 2004. The surgical technique used is the "endoscopic endonasal one-nostril transsphenoidal approach". In the first series of 41 patients the preoperative studies were MRI, CT, and hormonal examinations. MRI was performed in the immediate post-operative days in nine cases, hormonal examinations in 40 cases. Follow-up MRI was done three and six months after the operation in 25 cases. Starting with the use of the Brainsuite® the procedure has been modified. The routine studies remained the same (MRI, CT, hormonal examinations). In the Brainsuite® MRI with non-enhanced and contrast-enhanced sequences was executed before neuronavigational approach planning. After the apparently completed removal of the tumour, the MRI with non-enhanced and contrast-enhanced sequences is performed, and in case of residual tumour mass repeated. 23 patients (all macroadenomas) were controlled by MRI studies three months after the intervention. *Results:* From the macroadenomas in the first series (33) MRI showed partial removal (recurrences?) in 15 cases. 12 of these were operated again. In the second series of patients treated in the Brainsuite® about one-third showed tumour residuals in the MRI, which was removed in all cases, except for one, in the same surgical procedure. *Conclusion:* This study confirms the efficacy of intraoperative MRI in the surgical treatment of pituitary macroadenomas.

17 June, Friday, 13.00–15.00

Session 8

Neuroendoscopic interventions on the skull base

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Pure endoscopic endonasal odontoidectomy. Anatomical study. L.M. Cavallo, F. Esposito, A. Messina, P. Cappabianca, E. de Divitiis, M. Tschabitscher* (Naples, Vienna*)

Objective: Due to a number of aetiologies, the odontoid process can be affected by different pathologies which makes its resection sometimes necessary. The anterior transoral approach remains the gold standard technique for this goal. *Material and methods:* In the wake of the recent development of the endoscopic endonasal-transsphenoidal approach for sellar region lesions, we dissected 5 injected fresh cadaver heads in order to assess the feasibility of the endonasal transrhinopharyngeal route for the surgical management of lesions in the odontoid process region. A binostril approach has been used, with the removal of the posterior portion of the nasal septum. The surgical field comprehends a space, which extends from the sphenoid sinus cranially, to the Eustachian tubes laterally and the soft palate caudally. The nasopharyngeal mucosa is removed, the fascia of the paraspinous muscles is incised and the muscles laterally displaced. Then, the anterior arch of C1 is removed using a high-speed drill and bone rongeurs and the dens is exposed from its origin to the tip. Ultimately, the odontoid is removed, thus exposing the dura covering the cervicomedullary junction. The extended endoscopic endonasal approach here described requires some dedicated equipments. *Conclusion:* In this anatomical study, and in recently described clinical applications, it seems to be an intriguing alternative to the transoral approach in removing the odontoid process in selected cases. The potential benefits in treating odontoid pathologies through the nose instead of the mouth are described.

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Considerations about CSF fistulas' endoscopic treatment. D. Locatelli, F. Rampa, I. Acchiardi, M. Bignami*, F. de Bernardi*, P. Castelnuovo* (Pavia, Varese*)

Patients and methods: Between 1995 and 2004, 135 patients with non-traumatic and traumatic CSF rhinorrhoea were treated at the Department of Neurosurgery and Otorhinolaryngology of the Universities Pavia and Varese. All patients underwent surgery: 14 cases (10.4%) were treated by a combined microsurgical intracranial and endoscopic endonasal approach and 121 (89.6%) by the endoscopic endonasal approach alone. There were 66 males (48.9%) and 69 females (51.1%) with a mean age of 42 years (age range 1-75 years). We classified our patients in accordance with symptoms, etiology and CSF leak location: 59 patients had non-traumatic CSF leaks and 76 patients had traumatic CSF leaks, 39 of which were accidental and 37 iatrogenic. *Results:* In a cohort of 135 patients, the success rate at the first attempt to treat CSF leaks was 93.3%. We had no infective cases. Only 9 patients (6.7%) needed a second surgical repair: in one patient a coronal approach with frontal craniotomy was necessary, with a combined graft of temporal fascia, abdominal fat and pedicle pericranium flap. The other eight cases were treated with the endoscopic technique. Two patients needed a third endonasal endoscopic surgical repair with a successful result. We performed intraoperative fluorescein test in all cases; only one patient, already treated for posttraumatic epilepsy, had a minor seizure. Our cohort had a mean follow up period of 30 months. Our guidelines were standardized in a specific

protocol for each variant of CSF fistula. Patients went home after 3 to 5 days. The endoscopic postoperative evaluation was always conformed with MR studies at 6 months and follow up continued up to now, to exclude recurrences.

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Endoscope-controlled approach for trigeminal rhizotomy in the cerebello-pontine angle. U. Godano, C. Mascari, M. Zucchelli, M. Nicola, M. D'Andrea (Bologna)

Objective: The aim of this study is to assess the role of endoscopic surgery for trigeminal rhizotomy in the cerebello-pontine angle. *Patients and methods:* A pure endoscopic approach with the technique of endoscope-controlled microsurgery (videosurgery), in which direct manoeuvres with microsurgical instruments are performed under endoscopic view, has been performed in four cases of a severe, untractable form of trigeminal neuropathy (three cases of multiple sclerosis and one case secondary to peripheral trigeminal injury due to alveolar necrosis). The rhizotomy was performed through a minimally-invasive retrosigmoid approach with a 2 cm craniectomy. *Results:* The procedure was successful in all cases with a good clinical result and without surgical problems and/or major complications. In one case, affected by a concomitant severe cerebellar atrophy, we observed a post-operative cerebellar infarction, which was treated conservatively and recovered without neurological deficits. The operative advantage offered by the endoscope-controlled approach was the improvement of the direct vision obtained by the characteristics of magnification and lighting offered by the high definition-wide angled endoscopic image. *Conclusion:* Retrosigmoid endoscope-controlled surgery is a valid minimally invasive approach performing trigeminal rhizotomy. Endoscopy provides a unique way to explore the cerebello-pontine angle and to perform surgical manoeuvres without any traction on cerebellar tissue and/or neurovascular structures.

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Neuroendoscopy and neuroradiology: a joint effort in the treatment of intraventricular haemorrhages due to bleeding aneurysm. P.L. Longatti, A. Fiorindi, L. Basaldella, F. Di Paola (Treviso)

Objective: Intraventricular haemorrhages due to bleeding aneurysms are critical conditions often carrying a severe prognosis. Two main problems must be urgently faced: the secondary damage caused by intraventricular clot and hydrocephalus, and the risk of early rebleeding. Our technique of immediate endoscopic evacuation of intraventricular haemorrhage after securing the aneurysm with coils should solve acutely and within few hours this real challenge. *Patients and methods:* Between December 1995 and December 2004, nine patients (mean age 59 years) presenting with haematocephalus due to aneurysm rupture, were treated in our department by coiling and endoscopic clot aspiration extended to the whole ventricular system. A flexible endoscope was always preferred, using the working channel as a sucker. CT scans obtained before (always 6 hours from onset of symptoms) and immediately after surgery were compared for Graeb score and ventriculo-cranial ratio (VCR); Glasgow Outcome Scale (GOS) was assessed at 6 months. *Results:* All patients were treated within 2 days from onset, but at most at day 0. The procedure resulted in a satisfactory removal of ventricular blood: Graeb score was reduced from 11.44 \pm 0.72 to 4.33 \pm 2 ($p < 0.0001$). No 33.3%. Favourable outcome (GOS 3 to 5) was observed in 66.6% of cases. *Conclusion:* The early neuroendoscopic removal of blood casting from the lateral towards the fourth ventricle after coiling of bleeding aneurysms, is a feasible and valuable approach for a timely safe and complete management of these complex cases.

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Application of the neuroendoscope for intracranial aneurysm surgery. J. Zhao, S. Wang, Y. Wang, Y. Zhao (Beijing)

Objective: To discuss the role of the neuroendoscope in aneurysm surgery, analyzing its benefits and disadvantages. *Patients and methods:* 88 patients with 89 aneurysms were treated between 2/2000 to 11/2003 by clipping in microsurgical technique using the endoscope as an adjunct. Eighty-two aneurysms (eighty-one patients) were located in the anterior circulation, and seven were located in the posterior circulation. All of these cases were performed using a keyhole approach. The micro-doppler was applied intraoperatively before and after clipping. In 84 cases, endoscope-assisted microsurgery (EAM) was used in addition to microsurgical dissection and clipping for observation of the features of the aneurysmatic neck, perforators and verification of the optimal clip position. In 5 cases pertinent anatomic information could be obtained only with the endoscope. Using the neuroendoscope we can observe also the posterior communicating artery and the opposite anterior communicating artery behind the internal carotid artery without retraction of the ICA and the surrounding structures. *Results:* Postoperative angiography was performed for 86 patients after aneurysm clipping. There was no postoperative mortality, postoperative morbidity was 7.95% (7 cases), not related to the intraoperative use of the endoscope. *Conclusion:* The neuroendoscope is very useful for surgery of complex aneurysms, increases the feasibility of a complete clipping procedure, resulting in a reduced complication rate. The endoscope allows a better observation of the regional anatomy due to its magnification- and illumination effect, and its ability to look around corners. Therefore, it is a major advance in the microsurgical treatment of intracranial aneurysm surgery.

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Endoscopic anatomy of latero-basal key-holes to the posterior fossa. K.D.M. Resch, H.W.S. Schroeder (Greifswald)

Objective: Endoscopy is becoming accepted in assisting microsurgery. The use of endoscopy for minimizing the dimension of an approach is not usual. According to the par-endoscopic preparation concept very small approaches will be usable when the microscope is substituted by the endoscope. This evolution makes a more precise description of the endoscopic approach necessary. In this presentation 4 latero-basal key-hole approaches to the posterior fossa are differentiated and described. *Material and methods:* In 12 specimen endoscopy assisted (para-endoscopic) preparations were done. Laboratory setting was designed for surgical simulation conditions. Exclusively key-hole approaches were examined. Rigid endoscopes with 3mm and 5mm diameter and 5° or 30° optics (Wolf, Knittlingen) were used. All microsurgical instruments were at hand and clipping action has been done to show the spatial conditions in the depth. Results were documented by digital tape recording. *Results:* It was evident by anatomy to differentiate 4 typical locations of key-hole approaches to expose special areas and targets. The approaches were named according to their anatomical location: Asterion, – Subasterion, – Retrocondylar, – Transcondylar. From “Asterion-Keyhole” to Transcondylar-Keyhole” the extracranial route changes from short to a long route and the intracranial route becomes shorter. Asterion is the easiest approach and enables the best overview to the targets of the latero-basal posterior fossa. The retro- and transcondylar route need a deep extracranial preparation but enables an intracranial pathway to the targets around the foramen magnum. Approach-Plane: Asterion keyhole is positioned in a vertical plane, while Subasterion and Condylar keyholes present targets in a small angle of less than 45° presenting the neuraxis in a co-axial view and causing very unusual aspects of imaging. *Conclusion:* Four distinct key-hole approaches to the latero-basal posterior fossa can be differentiated

characterized by typical features regarding extra-intracranial route correlation, approach plane, targets visualization, and angle of approaching. The results of this study make an approach analysis and approach planning possible.

17 June, Friday: 15.15–16.15

Session 9

Neuroendoscopy: a worldwide survey

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Current status of neuroendoscopic surgery in Japan. H. Mori, K. Nishiyama, J. Yoshimura, R. Tanaka (Niigata)

Objectives: In Japan a Society for Neuroendoscopic Surgery has been founded in 1994 and we have hosted the 11th Annual Meeting last year. During this first decade an increasing number of neuroendoscopic surgery for various neurosurgical indications has been established. So we conducted a questionnaire survey of neuroendoscopic surgery as a project of the meeting. *Material and methods:* Out of 1237 neurosurgical institutions in Japan, 592 (47.9%) returned completed questionnaires. Amongst them, 316 (53.4%) had performed at least one neuroendoscopic procedure (endoscopic surgery and/or endoscope-assisted microsurgery) in the year 2003. 208 (75.5%) had 1-10 procedures per year, 34 (12.3) had 11-20, and 13 (4.7%) had 21-30. Only 6 institutions (2.1%) experienced more than 50 operations per year. The total number of neuroendoscopic interventions was 2710 and transsphenoidal surgery was most frequently performed (705, 26.0%). Out of 705 interventions, 276 were single endoscopic operations and 429 endoscope-assisted microsurgery. Aneurysm clipping was the second frequent endoscopic assisted microsurgical intervention (637, 23.5%). Endoscopic third ventriculostomy was done in 357 cases (13.2%), which was the largest number of single endoscopic interventions. Other indications were evacuation of intracerebral hematoma (251), tumor removal (190) (assisted 156), tumour biopsy (146), cystic lesions (117). In terms of third ventriculostomy, 357 procedures were performed at 126 institutions and most of them (112) had 5 or less cases per year. Only 5 institutions had more than 10 cases. This result disclosed an issue of little experience per one institution. *Conclusion:* Based on the above results, we have started to establish the guideline and minimal requirement in the training system to perform safe neuroendoscopic surgery. We present details of the results of the questionnaire survey and the proposed training system of neuroendoscopic surgery in Japan.

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Neuroendoscopic management of hydrocephalus in African children. Results from 1000 ventriculoscopic procedures. B. Warf (Mbale)

Objective: Shunt-dependency in children with hydrocephalus is more dangerous in the context of a developing country such as Uganda; thus the avoidance of shunting by primary neuroendoscopic management is particularly attractive. *Patients and methods:* In 4 years 1000 ventriculoscopic procedures for hydrocephalus in African children were performed at CURE Children's Hospital in Uganda while collecting data prospectively. 66% of the procedures were primary ETV, 10% were repeat ventriculostomy for failed ETV, and in 24% the ETV attempt was abandoned for reservoir or shunt placement. *Results:* The following was learned: 1) CSF infection was the single, most common cause of hydrocephalus (60%); 2) endoscopic third ventriculostomy (ETV) was suc-

cessful in 80% of children over the age of 1 year; 3) the outcome of ETV in combination with choroid plexus cauterization (ETV/CPC) was superior to ETV alone for infants <1 year old (67% vs. 47% success; $p < 0.0001$), especially for those with non-post-infectious hydrocephalus (74% vs. 38% success; $p = 0.0006$) and hydrocephalus associated with myelomeningocele (76% vs. 35%); $p = 0.0045$); shunting could be avoided in the majority of children; and, 5) ETV/CPC had lower infection (<1%) rates than shunting (9.7% and 4.1%, respectively). *Conclusion:* These results have compelled us to begin a program of training and equipping other centres in Africa to manage hydrocephalus with neuroendoscopic techniques through our Program for Advanced Training in Hydrocephalus (PATH).

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Endoscopic third ventriculostomy – our experience in Sidney. R. Jones, D. Kadrian, J. van Gelder, D. Florida, W. Stening, B. Kwok, C. Teo, M. Vonau (Sidney)

203 consecutive patients with a follow-up as long as 23 years were reviewed. Initially, a CT ventriculogram was used to demonstrate the site of the obstruction - later MRI. As the mean time between shunt revisions – excluding operations for infection – was over 5 years, the initial recruitment was slow for ETV – an experimental procedure at that time. Our earliest scopes did not have a working channel. We had relatively poor results in infants under 6 months without an associated myelomeningocele. This was due partly to our inability to assess the 3rd ventricular floor. The overall success rate was 89% (84-93%) 2 major permanent complications occurred. 2 patients died from late blockage. The families who have experienced problems associated with extracranial shunts are enthusiasts for ETV.

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Long-term follow-up of endoscopic third ventriculostomy for triventricular obstructive hydrocephalus. Results of a Cooperative Study of the Italian Neuroendoscopic Study Group. C. Mascari*, P.L. Longatti, M. Gangemi U. Godano, A. Fiorindi, F. Giordano, L. Genitori, G. Tamburrini, C. Di Rocco, R. Faggin, C. Alafaci, S. Cipri (Bologna*, Firenze, Messina, Napoli, Padova, Reggio Calabria, Rome, Treviso)

Objective: The aim of this study is to evaluate the long term results of endoscopic third ventriculostomy in the treatment of triventricular obstructive hydrocephalus. *Patients and methods:* We retrospectively evaluated the long term follow-up (>5 years) of 141 patients treated in eight Italian centres from 1994 to 1999. In our series there were 74 males and 67 females aged between 1 day and 75 years. The elective neuroradiological examination consisted in MRI images that allows different planes of vision and the CSF flow study, providing a more accurate diagnostic sensitivity. The postoperative results were evaluated both clinically and on MR data particularly considering the flow signal on sagittal T2 weighted images and the ventricular morphology and size. *Results:* The results reported in literature, indicate that endoscopic third ventriculostomy is the most effective treatment in cases of obstructive triventricular hydrocephalus caused by aqueductal stenosis and space-occupying lesions. In patients with infections or intraventricular bleeding endoscopic third ventriculostomy has considerable effects in selected cases. The long term results of our study show a success rate of 80% with a follow-up of more than five years. *Conclusion:* The success rate of third ventriculostomy after a long term follow up is not so different from its brief term results, showing that the endoscopic procedure has a long-standing effect. The authors discuss the impact on the clinical results of some different conditions such as the aetiology of the hydrocephalus and the age of the patients and analyse which factors can play a role in predicting the failure of the procedure.

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Mechanisms of hydrocephalus in neurocysticercosis. S.T. Zymberg, S. Calvalheiro (Sao Paulo)

Objective: Among most prevalent parasitosis of the CNS, cysticercosis remains a public health problem in many developing countries. Medical treatment is not completely satisfactory since both Albendazole and Praziquantel have doubtful effectiveness in intraventricular and cisternal forms. *Patients and methods:* From April 1995 to October 2004, 34 patients were endoscopically treated in our department. Preoperative protocol included neurological and CT/MRI following previous fluxogram. Third ventriculostomies and septostomies were performed when needed. *Results:* Female/male ratio was 2:1, mean age was 39 years (range 5-72 years). Signs and symptoms of raised intracranial pressure were the most prevalent. Distinct mechanisms of hydrocephalus were identified during endoscopic treatment despite careful preoperative imaging analysis. Lateral ventricle cysts, the most common location in this series, were identified as mass lesions, obstructing catheters, obstructing selectively the foramen of Monro or causing inflammatory changes in this region. Aqueductal and fourth ventricle cysts were evacuated in some cases by transaqueductal route. Temporal horn blockage was observed as a result of inflammatory ependymal reaction or presence of cysts. Interpeduncular cistern cysts were approached by third ventriculostomies. *Conclusion:* Neuroendoscopy is an excellent technique as a diagnostic and therapeutic tool in hydrocephalus related neurocysticercosis.

17 June, Friday: 16.15–17.30

Session 10

Hydrocephalus III – Shunts versus ETV

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A validation experiment for in utero neuroendoscopy. M. Vloeberghs, B. de Keersmaecker*, Y. Ville* (Nottingham, Poissy*)

Objective: Building on previous experience with in utero neuroendoscopy a validation experiment was set up to allow a controlled study of morbidity and mortality for in utero hydrocephalus in sheep as a guide for further human practice. *Method:* At 78 days of gestation, 7 gravid ewes were evaluated by ultrasound. Two ewes had twin pregnancy and one of each was used as a control. All fetuses were normal. Under general anaesthesia a laparotomy was done to expose the gravid uterus. Under ultrasound guidance a 20 Gauge needle was inserted in the foetal ventricular system. Maternal blood was taken and a varying amount, 1 to 4 ml, was injected into the ventricles using ultrasound. The sheep were transferred to the animal unit. Weekly ultrasound was done to check on the vitality of the foetus and the status of the ventricles. At 128 days of gestation a second laparotomy was performed. A neuroendoscopy was done in 6 of the 7 foetuses with dilated ventricles. The lambs were born naturally or delivered by caesarian section, sacrificed and the brains were fixated. MRI studies on the fixated brains were also done. *Conclusion:* This experiment showed that even small volumes of blood create in utero hydrocephalus. In 4 of the 7 foetuses the dilatation was visible 14 days after the injection. Upon delivery, none showed external signs of the procedure. MRI examination of the brain showed the trajectory of the endoscope to the ventricle without co-morbidity. Although blood was seen on the operative ultrasound only one haematoma was seen post mortem. This paper postulates that in utero hydrocephalus in fetuses with normal karyotype is of vascular origin. Neu-

roendoscopy is proved to be safe and not a cause of mortality of morbidity.

62
Shunts 2005 – 2010 – 2015 – State of the art and new trends. A. Aschoff, M. Scheihing, A. Unterberg, B. Hashemi (Heidelberg)

Objective: After an explosive development of the first generation of simple valves in the fifties, the technology stagnated over 30 years and consisted preferably of cloning. The second generation was inaugurated since the late sixties (adjustable valves 1969, anti-siphon 1973, gravitational 1975, negative feedback regulation 1987), but played no role before the nineties. As predicted by more than 700 own in-vitro-tests the theoretical advantages of adjustable, Orbis-like-and antisiphon-valves are clinically counterweighted (UK shunt registry, Drake) either by a persistent hydraulic mismanagement or inherent safety problems or both. The smart gravitational valves suggest a superior function. However, some problems such as abdominal counterpressure in adipous patients with overcompensation remain unsolved. *Methods:* After benchtests of 701 valves, discussions with experts, 14 visits in shunt companies, we condense some future trends of valve engineering. *Results:* Antisiphon- and Orbis-like designs have an exhausted potential. The magnetic susceptibility of adjustable valves, a source of permanent troubles, which increases massively in the age of 3-T-MRIS, may be solved by the second generation of adjustable designs such as Sophysa Polaris and Miethke ProGAV. Gravitational valves are an obligatory supplement of shunts, but need some adjustability too; 7 designs are proposed, one is patented. Telemetric ICP-probes and anti-infectious impregnations show a significant progress. Electronic valves are conceived, which are really "programmable" and allow a long-term storage of ICP-events as well as a controlled stepwise weaning of patients from the shunt. *Conclusions:* The developmental potential of mechanical designs is not exhausted, however the future will be probably electronically.

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Non-invasive brain compliance testing in patients with hydrocephalus: a provocative test to guide management. K. Manwaring, P. Manwaring, J. Manwaring, J. Brenner, D. Wickern, M. Manwaring (Phoenix)

Objective: We recently published a method to derive non-invasively a compliance curve in an individual patient by comparing phase shift between the ICP pulse derived by tympanic membrane displacement and the oximeter pulse of the earlobe. We more recently showed similar results by comparing phase of a supraorbital oximeter and a finger oximeter as a patient is excused on a tilt table from head up to horizontal to -45 degree positions. The supraorbital artery derives from the intracranial internal carotid artery and therefore shows phase shift as the space of the brain becomes less compliant. We have now adopted this simple outpatient test to the clinical environment for longitudinal management of patients with hydrocephalus. *Patients and methods:* 52 normal males, aged 18-25 were studied for brain compliance on the tilt table at 4 angles to derive an individualized compliance curve. 2 normal subjects were studied twice daily for 30 days to investigate stability of the compliance test in an individual. 20 patients with hydrocephalus were studied in various stages of management of their intracranial hypertension: before and after third ventriculostomy, with longterm functional shunt, in shunt failure, with overdrainage symptoms, and during weaning challenges with extended range shunts. *Results:* Normal subjects show a consistent baseline curve when compared against themselves and tolerate the provocative test well. Patients with treated hydrocephalus show 4 patterns: post effective III. ventriculostomy show more normalized compliance, despite inconsistent improvement in ventricu-

omegaly. Functional shunts deviate towards excess compliance at -30 degree head down position, confirming functionality. Overdraining shunts associated with excess drainage symptoms show excess compliance. Failed shunts create abnormally stiff patterns compared to normal subjects. *Conclusion:* This non-invasive provocative test increases diagnostic insight compared to clinical history, exam and imaging studies. Longitudinal data of an individual patient's compliance appear promising as an effective tool to guide weanability with extended range programmable shunts as well as confirming physiologic effectiveness post endoscopic fenestrations.

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The effectiveness of endoscopic third ventriculostomy in pediatric patients as an alternative to cerebrospinal fluid shunt revision. V. Etus, S. Ceylan (Kocaeli)

Objectives: The authors' clinical experience with third ventriculostomy (ETV) in the management of cerebrospinal fluid (CSF) shunt dysfunction in pediatric patients is presented. *Patients and methods:* The clinical data of twelve patients treated by ETV for malfunctioning shunts due to mechanical or dynamical complications were retrospectively reviewed. In the majority of the cases CSF shunts have been inserted in other neurosurgical units and patients were referred to our department for endoscopic intervention. Etiology of hydrocephalus was aqueductal stenosis in five patients, neonatal meningitis in one patient, Dandy-Walker malformation in one patient. Four patients had triventricular hydrocephalus accompanied by neural tube closure defects and one patient had posttraumatic hydrocephalus. *Results:* The mean age of the patients was 4.45 years ranging between eight months and eighteen years. The mean follow-up period was 26.5 months with a range between three and 66 months. Nine of the twelve patients experienced successful outcome, resulting in shunt independence. Of the three failures, symptoms related to increased intracranial pressure became manifest within a median of six days, resulting in a new CSF shunt placement. No delayed failures occurred. *Conclusion:* The results of our series show, that ETV may constitute a valuable alternative to CSF shunt revision in pediatric patients affected by triventricular hydrocephalus, who present with mechanical or dynamical CSF shunt malfunctions. Because ETV could be an opportunity for a hydrocephalic child to become shunt-free, it should be considered in all suitable cases as the treatment of first choice.

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Treatment of obstructive hydrocephalus: ETV or shunt? L.J. Vujotic, M. Jovanovic, V. Bascarevic, S. Ivanovic (Belgrade)

Objective: In treatment of obstructive hydrocephalus endoscopic 3rd ventriculostomy (ETV) is an accepted method in comparison to shunting procedures – or even better than shunt placement? *Patients and methods:* We have analysed all patients treated from 1998-2002 in our department using neuroendoscopic techniques, 88 with hydrocephalus (55 obstructive). The group of patients with shunt insertion was operated during the same period. The follow up period was 31.1 and 32.4 months, respectively. *Results:* There were no differences between the two groups preoperatively. Postoperative clinical improvement in the first follow up control examination showed both groups (ETV: 73.1% / shunted patients: 71.2%). Karnofsky index improved constantly, with no difference between the two groups. Ventricular size index showed a slight delay in normalization in the ETV group, but with no differences after the first control examination. Early complications occurred in 28 (55) patients after ETV and 20 (55) after shunt placement. Late complications, such as dysfunction, infection, chronic subdural hematoma etc were 6 (55) in the ETV group and 16 (55) in the shunt group. In the follow up period there was one ETV- and 11 shunt revisions. *Conclusion:* ETV is the treatment of choice for

obstructive hydrocephalus when compared to shunt placement, especially regarding late complication rate and re-operations. No patient with obstructive hydrocephalus should be shunted prior to ETV. Exceptions are rare tumours of the third ventricle causing hydrocephalus, post-infectious hydrocephalus and children younger than 6 months of age.

66

Third ventriculostomy in septum pellucidum agenesis: anatomical considerations and technical difficulties. A. Cordoba, R. Alberti (Montevideo)

Objectives: Neuroanatomical variations in patients with chronic hydrocephalus are very common. Corpus callosum and septum pellucidum agenesis can reveal numerous genetic syndromes and are very important in neuroendoscopic landmark identification. We describe the most common neuroanatomical variations and technical problems when a third ventriculostomy is performed in a patient with a septum and corpus callosum agenesis. *Patients and methods:* Twenty patients between 8 and 13 years old with shunt failure and septum pellucidum agenesis were operated by endoscopic third ventriculostomy and shunt removal. The intervention were performed using a rigid endoscope and a special canula in cases where the foramen of Monro was small in order to facilitate the access to the third ventricle. *Results and conclusion:* Despite the anatomical variants, all of the procedures were performed successfully in a very tiny third ventricle without complications. The advantages of this technique compared to the application of flexible endoscopes are discussed.

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Endoscopic treatment of isolated fourth ventricle in children. C. Ruggiero, P. Spennato, M. Giordano, V. Trischitta, F. Aliberti, E. Cianciulli, G. Cinalli (Naples)

Objective: To evaluate the role of endoscopic aqueductoplasty as an alternative to "Y"-shunting of open craniotomy in the treatment of isolated fourth ventricle (IFV) in children. *Patients and methods:* Seven patients, with symptomatic IFV, underwent neuroendoscopic treatment by the means of endoscopic aqueductoplasty alone or endoscopic aqueductoplasty followed by placement of a stent in the aqueduct. The mean follow up was 26 months. Aqueductoplasty alone was performed in 3 cases, aqueductoplasty and aqueductal stenting in 4 cases. In 5 cases a precoronal approach was used, while in 2 cases a sub-occipital approach was preferred. Re-stenosis of the aqueduct occurred in 2 patients where stents had not been placed. One patient underwent endoscopic re-opening of the aqueduct and placement of a stent, the other underwent shunting of the fourth ventricle. Stenting was successful in all 5 cases with clinical and radiological improvement of IFV. Hydrocephalus was controlled by a single shunt in 6 cases (86%) and by double shunt in 1 case. *Conclusions:* Stenting of the aqueduct is more effective in preventing aqueduct re-occlusion than aqueductoplasty alone. The choice of approach (pre-coronal, sub-occipital) and of stent design ("cut" and "not-cut" catheters) is dictated mainly by the size of the ventricular system, the presence of other localizations inside the ventricular system that need to be fenestrated and by the eventually associated need of revision of a supratentorial shunt.

17 June, Friday: 17.30–19.00

Session 11

*Hydrocephalus IV – Complex hydrocephalus, Normal pressure hydrocephalus***68****Neuroendoscopic management of multiloculated hydrocephalus.**

P. Spennato, M. Giordano, C. Ruggiero, F. Aliberti, E. Cianciulli, G. Cinalli (Naples)

Objective: To evaluate the role and effectiveness of neuroendoscopy in the treatment of multiloculated hydrocephalus as alternative to multiple shunting. *Patients and methods:* Thirty children affected by various forms of multiloculated hydrocephalus, underwent 48 neuroendoscopic procedures, according to the different radiographic appearance of their multiloculated hydrocephalus, including: intraventricular septa fenestration (24 cases), septum pellucidum fenestration (20 cases), aqueductoplasty with or without stenting (8 cases), Monro-foraminoplasty (3 cases) and third-ventriculostomy (11 cases). In most patients these procedures were associated. The patients were divided into two groups: group A included 23 children already shunted; group B included 7 children never shunted before. Mean follow up was 34.2 months. Control of hydrocephalus by single shunt or no shunt was achieved in 25/30 children (83.3%), in 18 following a single endoscopic approach. Mean shunt revision rate in group A dropped from 2.07/year to 0.35/year following endoscopy. Endoscopic reoperation rate was 0.31/year, so total operation rate dropped to 0.66/year after endoscopy. In the group B at the end of the follow-up, 3 children were shunt-free, 3 needed a single shunt and 1 required two shunts. Two patients had repeat endoscopic surgery and 2 patients had shunt revisions, accounting for a shunt revision rate of 0.07/year, an endoscopic re-operation rate of 0.19/year and a total operation rate of 0.26/year. *Conclusions:* Neuroendoscopy, allowing different procedures in a minimally invasive way, offers encouraging results in the treatment of multiloculated hydrocephalus. Early diagnosis and early treatment are the key of success.

69**Endoscopic aqueductoplasty: cranial trans-foraminal versus caudal trans-fourth ventricular approach.** I. Gawish, A. Stadie, R. Reisch, A. Pernecky (Mainz)

Objectives: Endoscopic third ventriculostomy is a well-established management of obstructive hydrocephalus. Nevertheless, the pathoanatomical situation is not always suitable for third ventriculostomy. In those patients, it is necessary to consider endoscopic aqueductoplasty either through the foramen of Monro or through the fourth ventricle. The choice of the approach depends on the site of the membranous obstruction and individually of the intraventricular anatomy. The aim of this study is to discuss the selection of the approach, the efficacy and the drawbacks of the endoscopic aqueductoplasty in both approaches. *Patients and methods:* Endoscopic aqueductoplasty has been performed in 13 patients with membranous obstruction of the aqueduct – 5 patients through the fourth ventricle (group A) and 8 patients through the foramen of Monro (group B). *Results:* All patients improved from hydrocephalic signs, 3 patients of group B had ocular motility disturbances and one patient from group B had a transient inferior oblique weakness. The complications were mainly related to the approach planning. *Conclusion:* The endoscopic aqueductoplasty is an effective method to treat membranous obstruction of the aqueduct. Operative complications are mainly related to the ap-

proach planning. Therefore it is very important to select the approach based on the individual patho-anatomical situation.

70**3100 telemetric ICP-measurements at home under daily life conditions in 5 patients over max 3.5 years.** A. Aschoff, K.E. Richard*, A.M. Messing-Jünger*, K. Kiening, B. Hashemi (Heidelberg, Düsseldorf*)

Objective: Invasive ICP-measurements incl. prechamber punctures on shunt-patients are at risk for infections and many problems exist only temporarily and are undetectable in single registrations. Despite of 37 years development ICP-telemetry plays a minimal role in practice due to technical (drifts) and difficult handling. *Methods:* A new telemetric transducer (ICP-TeleSensor) is able to register negative ICP. We implanted the device in 5 patients with complicated hydrocephalus (up to 60 previous shunt revisions) with clinically suspected shunt-problems. We trained the patients, to measure the ICP for itself 6 times/day in horizontal and sitting position and rented the apparatus. *Results:* The patients registered over 97, 96, (3/4 periods), 14.8 resp. 7 days their ICP with 1820, 1128, 120 respect. 2X40 single measurements at home. Due to the simple handling there were no problems for the patients. In three cases a correct function of implanted gravitational valves in both body positions could be confirmed and a shunt revision could be avoided. In 4 periods a shunt malfunction could be clearly demonstrated incl. normalization of ICP after shunt revision. In further follow-up examinations three probes drifted, each one remained stable over at least 1 resp 3.5 years. *Conclusion:* The progress in telemetry allowed for the first time, to measure the ICP at home under daily conditions over a period of more than three years. This is a new dimension of non-invasive and reliable valve-tests in-vivo and a method to analyse clinical symptoms.

71**Endoscopic third ventriculostomy in idiopathic normal pressure hydrocephalus.** M. Gangemi (Naples)

Patients and methods: A series of 30 patients with idiopathic normal pressure hydrocephalus (INPH) younger than 75 years of age and treated by endoscopic technique from January 1994 through December 2002 was analysed; they were compared with those of 14 studies reporting patients treated by shunting. All had a preoperative clinical history of 1 year or less, prevalence of gait disturbance with scarce or mild dementia, marked ventricular enlargement on magnetic resonance imaging (MRI) and intracranial pressure values ranging from 8 to 12 mm Hg. All were studied by a phase-contrast MRI flow study 1 month after ETV. The 14 reviewed series of patients treated by shunting (all published after 1980) each include more than 25 patients, for a total of 777 patients. *Results:* The overall rate of neurological improvement after ETV in our series was 72% (including two patients re-operated because the absence of flow on the MRI); this percentage is slightly higher than found in the 14 series of shunted patients (66%). Gait disturbance showed a high improvement rate, compared with other symptoms, both in our ETV study and in other shunting series. Postoperative complications occurred only in one patient (3.3%) with an intracerebral frontal hemorrhage and 37.9% of patients from the series including shunted patients. *Conclusion:* In patients with INPH showing short duration of symptoms, prevalence of gait disturbance and slight mental impairment, ETV provides similar results to those of shunting. We suggest performing ETV in these patients and reserving shunting only for those who do not improve after ETV.

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Disadvantages of endoscopic ventriculostomy compared with VP-shunt implantation in cases of normal hydrocephalus. S.A. König, A. Gräwe, U. Meier (Berlin)

Objective: Unlike shunt surgery endoscopic ventriculostomy has not been evaluated sufficiently in cases of normal pressure hydrocephalus. *Patients and methods:* Between 1997 and 2003 88 patients were included in this study. Diagnosis included clinical symptoms, intrathecal infusion test with lumbar and/or measurements of ventricular size, spinal tap-test, and CSF flow MRI studies before and after the intervention. In 70 patients (80%) we implanted a VP-shunt with a dual switch valve, 18 patients (20%) were treated by endoscopic third ventriculostomy. Using the NPH recovery rate and the clinical grading for hydrocephalus by Kiefer we compared postoperative results of both groups 12 and 24 months after surgery. *Results:* In the shunt group 11 re-operations were necessary (16%), including 4 infections (4%), 2 shunt obstructions (3%), 3 overdrainages (3%) and 2 catheter dislocations (3%). In the ventriculostomy group was one pneumatocephalus and one partial thalamus lesion with transient clinical symptoms. In both groups we had cases with underdrainage, 4 after shunt implantation (6%), and 6 after ventriculostomy (33%). We treated those shunt patients by implanting valves with lower pressure level, and those from the ventriculostomy group with gravitational valves. There was one patient (6%) with a lethal complication in the ventriculostomy group due to a ventricular hemorrhage. *Conclusion:* Because of the high rate of underdrainage after ventriculostomy in cases of NPH we do not recommend this procedure for the treatment of this special type of hydrocephalus. We assume that patients initially treated with ventriculostomy develop a secondary CSF resorption disorder due to progression of NPH. Our treatment of choice is a VP-shunt placement with a programmable gravitational valve.

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NPH endoscopic treatment and ICP monitoring. P.A. Oppido, F. Cattani, C. Carapella, E. Occhipinti, E. Morace (Rome)

Objective: Today, normal pressure hydrocephalus (NPH) is treated conservatively or by shunt insertion. Preoperative diagnostics tests to select patients for shunting are still debated. Up today the clinical history of the patient, according to Hakim, remains the main criteria of choice for shunting. Endoscopic third ventriculostomy (ETV) for NPH treatment has been recently suggested. In contrast to shunt operation the indication for an endoscopic ventriculostomy in NPH patients is not scientifically established. *Patients and methods:* We report our short experience to discuss the selection criteria in 4 patients undergone to ETV. Before surgery, by clinical grading, MRI study and epidural monitoring the patients were selected. All patients showed hydrocephalus and the typical Hakim syndrome. In 3 patients ICP monitoring revealed reduced cerebral compliance. Two patients had a rarification of the septum pellucidum. *Results:* There were no intraoperative complications, no postoperative morbidity or mortality. Follow-up of the patients ranged from 16 to 6 months. In all patients gait disturbances improved, while in 2 cases dementia persisted. MRI studies showed unchanged ventricular volumes in all patients. *Conclusion:* According to our experience ETV can be an alternative and safe treatment option in selected NPH patients with dynamic and anatomic signs of reduced cerebral compliance. The indications for ETV are slightly different and more precise than that for shunting.

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Endoscopic 3rd ventriculostomy from OR to bedside. A.F. Canestra, J.G. Frazee (Los Angeles)

Objective: Patients with normal pressure hydrocephalus may benefit from an endoscopic 3rd ventriculostomy (ETV). This procedure is commonly performed with intubation under general anesthesia. However, many of these patients are of advanced age and poor health, and may benefit from the avoidance of general anesthesia. Additionally, precious OR time, can be conserved for large cases. Here we present the development of a percutaneous bedside ETV. *Patients and methods:* Four subjects underwent percutaneous ETV. All subjects had classical symptoms for NPH, and improved with prior large lumbar puncture. The initial ETVs were performed in the operative suite under general anesthesia until the instruments and procedures were perfected for the bedside. Procedures began with the adaption of a fiberoptic neuroendoscope (Storz Co. Tuttlingen) with portable video/light system (Medipack). Burr hole craniotomy was initially performed with use of a power drill, and then progressed to twist hole using a disposable access kit. The endoscope was inserted through a percutaneous stab wound incision and 14 French peel-away catheter. Once the ETV was completed, stab incisions were closed with a single figure of nylon suture. *Results:* Four patients diagnosed with normal pressure hydrocephalus underwent this percutaneous procedure. Patients underwent MAC combined with local anesthesia. A small stab wound and 6 mm twist drill burr hole was performed in the right frontal region. A 14 French peel-away catheter was inserted into the lateral ventricle and afterwards the endoscope was introduced. The ETV was performed with a forceps punctured just posterior the infundibular recess. Clinically, all patients responded well to ETV. Operation time was less than 25 minutes. There were no complications. *Conclusions:* The percutaneous endoscopic 3rd ventriculostomy is a straightforward adaption of the traditional procedure. It is safe, and may be performed in a procedure room or ICU setting, reducing OR use.

18 June, Saturday: 08.00–09.00

Session 12

Results and complications

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The reality of “learning curves” learning disability and innovation in neurosurgery. A. Aschoff, H.H. Steiner, R. Wirtz (Heidelberg)

Objective: A common slogan are “learning curves”. Generally it is suggested, that they are steep and successful. The real process of neurosurgical innovation is not investigated. *Material and methods:* We analysed the history of neurosurgery and selected fields of medicine and science to clear the typical time lag between first description and general acceptance. *Results:* Learning in medicine shows a wide range: 1. The rapid worldwide acceptance is possible, but a rare exception. Examples are the LP (Quinke), the x-rays (Röntgen) and the RNA double helix. 2. A relatively fast spread (2-3 years) shows Horsley’s laminectomy, the Riva-Rocci-method or the Penicillin (Fleming). 3. Often the take-off requires one decade. The first artificial valve was implanted in 1949 (Nulsen), but the general breakthrough of shunts followed around 1960. 4. Many innovations need decades: The endoscopic ventriculostomy was described by Mixer in 1923, reinvented by Fukushima in 1973 (fiberglass) and Griffith in 1975 (Hopkins), but

the general use was delayed until the nineties. The anesthetic effects of ether were published by three authors 1805-20, but sco-tomized in the surgery till 1846. 5. Surprisingly we found even numerous "negative learning curves": The foramen of Magendi was described by Galen, but fell into oblivion over 1700 years. Mendel published his genetic laws in 1865; they were completely forgotten up to 1900. The adjustable valves, implanted by Matson in the early fifties and by Kuffer in Bern in 1969 must be reinvented in the 80ties. *Conclusion:* Empirical learning curves are widely ranged and mostly flat, sometimes even decreasing. The mean time lag between innovation and acceptance may be 20 years, in selected cases 50 years or even centuries.

76 Complications following neuroendoscopic surgery in children. G. Cinalli, P. Spennato, C. Ruggiero, F. Aliberti (Naples)

Objective: To evaluate the incidence of complications of neuroendoscopic procedures in children. *Patients and methods:* Complications recorded in a prospectively collected endoscopy database were analysed; the medical histories of the patients and the surgical procedures were reviewed. *Results:* Complications occurred in 34 out of 213 (15.9%) procedures performed for the management of obstructive hydrocephalus (119), multiloculated hydrocephalus (53), arachnoid cysts (26) and intraventricular tumors (12). CSF infection was the most frequent (11 cases). Subdural hygroma required subdural shunting in 11 cases. In one of these cases infection of the subdural space occurred and required a craniotomy. CSF leak occurred in 8 cases; intraventricular haemorrhages in 3; technical failures in 6; subcutaneous CSF collection (managed with lumbo-peritoneal shunt) in 1, thalamic haematoma and postoperative transient akinetic mutism in 1. This patient suddenly died six months later, probably as a consequence of closure of the stoma. Two patients developed secondary compartmentalization of the ventricles, following complicated ETV; one following intraventricular haemorrhage, the other following a failed attempt of ETV and subsequent CSF infection. Both patients required further surgical procedures (multiple shunting and endoscopic septa fenestration). One of these had permanent sequela (epilepsy and psychomotor delay). In 9 cases these complications were associated. *Conclusions:* Complication rate of neuro-endoscopy is not negligible in children. Careful selection of patients on pre-operative imaging studies and intensive training of surgeons are mandatory to improve results.

77 Complications of neuroendoscopic intracranial operations. V. Rhode, V.A. Coenen, A. Lytvyn, J.M. Gilsbach (Aachen)

Objective: During the last decade, endoscopic intracranial surgery became increasingly popular. In general, neuroendoscopy as a minimally invasive procedure is considered to have a low risk profile for the patient. It is the aim of this study to investigate, how safe intracranial neuroendoscopy really is. *Methods:* The demographic clinical (pre-, postoperative, follow-up examinations) and operative data of the neuroendoscopic operations of the first author were prospectively collected and entered a data bank. For this study, the data bank was screened for intra- and postoperative complications. *Results:* A total of 112 neuroendoscopic procedures (66 endoscopic third ventriculostomies (ETV), 17 fenestrations for non-tumorous cysts and multi-loculated hydrocephalus, 27 tumour resections or biopsies, 2 hematoma evacuations) were performed by the first author. In 10 of the 112 operations, 11 complications (9.8%) occurred: CSF leakage n=3, transient hemiparesis n=2, transient psycho-syndrome n=1, lethal myocardial infarction n=1, lethal brain stem herniation 1 year after ETV n=1). *Conclusion:* The transient morbidity rate was 1.7%, the permanent morbidity rate 0%. The mortality rate was 1.7%, but both deaths were not re-

lated to the operative procedure itself. We conclude, that intracranial neuroendoscopy is a safe procedure if done by experienced hands.

78 Retrospective analysis of 379 neuroendoscopic interventions (8 year experience). L. Bognár, B. Markia (Budapest)

Objective: Neuroendoscopic procedures are available in the National Institute of Neurosurgery since 1998. During this 8 years period 379 operations have been performed by the first author. In the first year only 7 endoscopic procedures have been done, while in 2001 this number has been increased to 46 patients. *Patients and methods:* Patients' age ranged from 2 weeks to 73 years. There were 230 children and 149 adults. The most common indication was hydrocephalus (82%), the second was arachnoid/intraventricular cysts (16%). Neuroendoscopy was also used in some cases of tumour biopsy and for treatment of other lesions such as colloid cysts. Minimum follow-up time was 6 months. *Results:* There was no surgical mortality. The overall complication rate was 7.8%, the most frequent complications were subdural hematoma/hygroma and CSF leakage. Wound infection, ventriculitis intraventricular bleeding, diabetes insipidus were rare (under 1%). In five cases surgery was abandoned because of bleeding obscured the visual field. In one case the bleeding derived from the basilar tip resulting in a massive subarachnoid hemorrhage. Persistent morbidity rate was 0.79%. The placement of a ventriculo-peritoneal shunt was necessary in 22% children who were treated primarily by neuroendoscopy. Children under 6 months of age needed shunt placement in 46%; in children older than 6 months only 16% needed a shunt. The series have also been analysed concerning the rate of re-endoscopic procedures, and the effectiveness of ETV after shunt failure. *Conclusions:* The analysis of our results and their further analysis may help to improve the techniques applied in endoscopic neurosurgery.

79 Complications of endoscopic aqueductoplasty and stenting. M.J. Fritsch, K.H. Manwaring, H.M. Mehdorn (Kiel)

Objective: Endoscopic aqueductoplasty has been established as one option for the treatment of aqueductal stenosis and isolated 4th ventricle. We previously reported our surgical technique and results. We now summarize a 2-institution experience in regard of complications and lessons learned. *Patients and methods:* We retrospectively analyze treatment and outcome of 24 patients who underwent endoscopic aqueductoplasty with or without stent. Surgeries were performed between July 1996 and December 2003. Mean age at time of surgery was eight years (4 months–36 years). Mean follow up was 24 months (12–84 months). *Results:* The following complications occurred: 1 infection/ventriculitis that required removal of the stent and subsequent re-stenting, 1 transient and 2 permanent oculomotor paresis, 1 asymptomatic posterior fossa hygroma, and 2 patients with stent migration (complication rate 29%; 7/24 patients). Reclosure rate following simple aqueductoplasty without stenting was determined by the etiology of the aqueductal stenosis. *Discussion and conclusion:* Endoscopic aqueductoplasty without or with stenting has a learning curve, as any other surgical procedure. Complications can be avoided or reduced by learning from previous experiences. Stent migration can be avoided by placing a stent that communicates lateral, 3rd and 4th ventricle and is secured by a subcutaneous burr hole reservoir. Reclosure rate following aqueductoplasty can be reduced by stent placement.

18 June, Saturday: 09.00–10.30

Session 13

*Spinal neuroendoscopy I***80**

Advances in minimally invasive spine surgery. R.G. Fessler, S. Christie, J. Song (Chicago)

Attempts at minimally invasive approaches to the spine have been documented since the 1960's. Initial attempts of minimally invasive procedures that reproduced open surgical technique were hampered by difficulty with visualization and instruments which were not designed for working down a relatively narrow channel. Automated percutaneous lumbar discectomy, chemonucleolysis and foraminal epidural endoscopy were attempted in the 80's and 90's, but achieved limited success rates compared to microendoscopic discectomy. Transabdominal and transthoracic techniques provided access to the ventral spine, but the technical difficulty of the procedure limited their widespread acceptance. However, the advance of visual technology and the development of instruments useful in endoscopic surgical technique in the 90's enabled the development of tubular retraction procedures simulating open surgical technique. Initially, these techniques enabled only simple discectomy surgery of lumbar disc herniations. At this time, nearly all surgical procedures for the spine can be done through minimally invasive technique. Although long term studies will require several more years of data collection before comparisons to open techniques will be possible, short term data evaluations suggest that patients have less intraoperative blood loss, shorter ICU and hospital stay, decreased post-operative pain and pain medication, and more rapid return to daily activities. This presentation will review the current procedures being performed through minimally invasive technique, and focus on the detailed results of several common procedures.

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A multipurpose retractor system for spinal endoscopy and microsurgery. F. Duffner, T. Bauer, M. Tatagiba, D. Freudenstein (Tübingen)

Objectives: The purpose of the following paper was to design a retractor system which can equally used for neuroendoscopic and microsurgical procedures. All currently available systems for spinal endoscopy still use tubular retractors with limitations regarding flexibility, stability and accessible working space. The authors present first clinical results in a series of 40 consecutive patients. *Patients and methods:* The system enables the neurosurgeon a variety of features adaptable to different anatomical situations. The variable fixation of the valves within the base plate allows a continuously adjustable working space. Up to seven valves from different directions can be used. The individually designed 90° offset fibre optic endoscope can also be variably fixed within the base plate. All components of the retractor system are made of titanium. The endoscope and retractor system are autoclavable. 39 patients with herniated lumbar discs (HLD) and one patient with a herniated cervical disc (HCD) were operated upon. Levels operated included L4/5 (n=15), L5/S1 (n=24), C6/7 (n=1). Clinical outcomes were accessed using the modified MacNab criteria with an average 6-month follow-up after surgery. *Results:* Our preliminary clinical results show the safety and efficacy of this system in the surgical treatment of disc disease in carefully selected patients.

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Intervertebral disk disease treated by endoscopic guidance. A.P. Fabrizio, M. Zucchelli, A. Barbanera (Bologna)

Objectives: Minimally invasive spinal surgery is constantly growing and is a valid alternative and /or aid in vertebral pathology. Arthoscopic/endoscopic illumination and magnification has been applied to sectors where direct vision is difficult to attain. These procedures are realized in collaboration with expert thoracolumbar surgeons. Thoracic disk herniation represents 1-6% of all disk herniations in major series reported. *Material and methods:* The preferred route for the transthoracic endoscopic approach is T10-11. However, 30% of these the disk herniations are near the dorsal-lumbar junction. Discopathy at the dorsal-lumbar junction requires a modified postero-lateral approach useful at the T11-L1 level. Application of the endoscope in the interspace once the space is produced allows the direct vision to the lesion and the dural surface. Application of a Titanum "cage is often used to maintain the disk space and to avoid pseudoarthrosis. *Results:* Our series present 55 patients. Translaminar arthrodesis will also be described for instability treated with interbody fusion (anterior lumbar interbody fusion). A series of 24 patients with failed-back surgical syndrome L4/5 and L5/S1 will also be demonstrated showing the advantages and disadvantages of the technique. *Conclusion:* The authors present their experience with minimal invasive treatment of lumbar disk herniation. This approach limits tissue damage, blood loss and hospital stay.

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Endoscopic posterior cervical foraminotomy: indications, surgical technique and results. P. Ferroli, A. Franzini, V. Nazzi, M. Marchetti, L. Galosi, G. Broggi (Milano)

Objectives: Posterior foraminotomy is a well-known surgical procedure that can be used for the treatment of cervical discogenic radiculopathy. Recent reports emphasize the advantages of anterior cervical approaches with instrumentation techniques and modern neurosurgeons seem to be less familiar with the posterior approach. We introduced in our institution this procedure with the objective of analyzing its feasibility by using a minimally invasive endoscopic technique. The indications, the surgical technique and the results obtained by endoscopic posterior cervical foraminotomy are described. *Patients and methods:* Fifty patients who underwent surgery in the period of 1999 to 2003 were analysed retrospectively. Relief of pain and motor and sensory improvement were the criteria used to measure the success of the procedure. *Results:* Most of the patients presented with acute radiculopathy resistant to at least one month long conservative treatment. Radicular involvement was as follows: 24 cases-C7 root, 19 cases-C6 root, 4 cases-C5 root, and 3 cases-C8 root. Total relief of radicular pain was obtained in 49 of 50 patients (98%) with no pain recurrence at 1-4 yrs follow-up. Recovery of sensory and motor deficits was always observed during the first post-operative month. The mean hospitalisation time was 2 days. There was no mortality and no morbidity. *Conclusion:* Posterior foraminotomy was found to be a feasible technique through a minimally invasive endoscopic approach that minimizes the surgical exposure to the paraspinal muscles and cervical spine dynamic. Preserving the anterior segment of the spine, avoiding instrumentation and related morbidity can represent an advantage of this technique over the anterior discectomy.

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Preoperative localisation of thoracic disc protrusions using Myelo-CT guided transpleural puncture: technical note. E.M.J. Cornips, E.A.M. Beuls, J.T.A. Wilmink, P.A.M. Hofman, R. Snoep (Maastricht)

Objective: Video-assisted thoracoscopic microdiscectomy is the best technique to treat thoracic disc protrusions. Correct localisation is difficult and wrong level exploration an ever present threat. Whenever the protrusion is not found, no other option exists than to end the operation. We looked for a reliable, time-efficient localising technique. *Patients and methods:* In 59 consecutive cases, one day preoperatively intrathecal contrast was administered and a CT scan performed in prone position. Using local anesthesia and intermittent CT guidance, a thin biopsy needle was advanced approximately 3 fingers paramedian, above the rib corresponding to the involved segment, until it perforated the pleura. Starting the operation the next day the needle and the corresponding pathological level were identified endoscopically. *Results:* The lumbar tap was well tolerated. Myelo-CT clearly demonstrated all protrusions whether or not calcified as well as important surrounding structures as the aorta and the costodiaphragmatic recess. The needle was well tolerated. One patient developed a pneumothorax needing drainage shortly after procedure. One level was initially misidentified because the broken needle had retracted subpleurally. The correct level (ranging between T3-T4 and T12-L1) was easily identified in all other patients. *Conclusion:* The Myelo-CT provides highly detailed anatomical information, which is often helpful to determine the side of the operative approach as well as the extent of bone removal needed. Needle localisation obviates the need for fluoroscopy at the beginning of the operation, saves OR time and allows the surgeon to focus on the technically demanding procedure. Complications are few.

18 June, Saturday: 10.45–12.30

Session 14

*Spinal neuroendoscopy II, Miscellaneous indications***85**

Far lateral lumbar disc herniation: computer-assisted, image-guided percutaneous endoscopic fragmentectomy. V. Dallolio (Lecco)

Objectives: The author presents his experience (11 cases) in endoscopic removal of far lateral (extraforaminal) lumbar disc fragments. Methods and technical aspects are also discussed.

Methods and technical aspects: The approach to the foraminal area is performed with the patient under local anesthesia, according to Onik's percutaneous discectomy technique. This technique, with the use of CT and/or MR images, permits placement of the rigid endoscope (Wolf Co, Germany) in the proximity of the herniated disc fragment. With the endoscope in place, the real challenge of the procedure is to identify the disc fragment with respect to other anatomical elements (i.e. osteoarticular, nervous, vascular), which crowd the area of interest. Removal of the disc fragment is typically associated with immediate resolution of pain. Based on satisfactory preliminary results, the authors suggest that this procedure may be considered as optimal treatment for lateral herniated disc, which represents approximately 10% of disc prolapses. It is generally accepted that the ideal field for this method is "extra-anulus", thus decompressive discectomy is not required. Recently, the authors introduced a virtual fluoroscopic system as-

sociated with the VectorVision 2 Neuronavigation System (Brain-LAB, Munich, Germany). This method significantly minimizes radiation exposure for the patient and for the surgical team as well as allowing real-time visualization of the surgical instruments (cannula, endoscope, biopsy forceps), based on previously acquired imaging. Moreover, modification of the dynamic reference clamp may considerably reduce the invasiveness of the system and the duration of the procedure.

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Mini-open endoscopic-controlled technique for lumbar disc herniation surgery. E.R. Orlando, G. Trillo (Rome)

Objective: The optimal management of symptomatic lumbar disc herniation still remains controversial. The aim of the paper is to examine the flexibility, the safety and the handiness of mini-open endoscopic-controlled technique for lumbar disc herniation surgery. *Patients and methods:* In our institute classic lumbar microdiscectomy has been used since 1989. On March 2002 we introduced the endoscopic technique performing 128 (72m and 56f) consecutive treatments: 9 of these patients were undergoing the second surgical intervention. The mean age was 46 years (24yrs to 76 yrs). 75 patients underwent surgery at L4-L5 level; 41 at L5-S1; 4 at L2-L3 and 8 at L3-L4 level. We used a 4 mm in diameter rigid endoscope with 0°, 30° and 90° angle of view (Karl Storz Co®). We kept the endoscope in freehand technique and fixed in a holder during the removal of the herniation. *Results:* The mean operation time was 70 minutes. 124 patients had an improvement of their sciatica and low back pain, being mobilized and discharged in 24-48 hours. The only complication was a dural tear in 2 patients treated for lumbar disc herniation relapse. *Conclusion:* The advantage of the endoscope-controlled mini-open technique is the minimal invasiveness, with minimal trauma for spinal muscles, the direct access to the conflict between herniation and the spinal root and the better exploration of periradicular, peridural and, on occasion, intradiscal spaces. Furthermore the surgeon does not have to maintain an obliged position as he does for microsurgical intervention.

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Spinal neuroendoscopy in Uruguay: report of ten first cases. A. Cordoba, R. Alberti (Montevideo)

Objectives: Spinal neuroendoscopy is an attractive method in minimally invasive neurosurgery. Epiduroscopy and spinaloscopy are used for specific pathologies as low back pain, post-laminectomy syndrome and peridural fibrosis. Other pathologies are included. We present the first national experience in spinal neuroendoscopy. *Patients and methods:* In 2004 ten patients between 4 months and 68 years old (6 female and 4 male) were operated on using a 0.9 mm semiflexible spinal neuroendoscope. This series included 6 peridural fibrosis after herniated disc surgery, 1 dorsolumbar syringomyelia, 1 dorsal arachnoid cyst, 2 stem cells implants in amiotrophic lateral sclerosis. *Results and conclusions:* No intraoperative or postoperative complications were observed. The results of our preliminary series are discussed.

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Management of non-syndromic multiple suture synostosis using minimally invasive endoscopic assisted techniques. D.F. Jimenez, C.M. Barone (San Antonio)

Objective: Onset of multiple suture craniosynostosis during pregnancy presents as a complex and difficult problem for the treating surgeon. Rapid brain growth during the first nine months of life can lead to major deformities of the craniofacial skeleton. Conventional treatment paradigms advocate waiting for the child to

reach six to nine months of age at which time major and extensive craniectomies and cranial vault remodeling are recommended. Significant blood loss associated with these procedures precludes operating on very young infants. In order to address this problem at an early stage, we instituted minimally invasive endoscopic assisted craniectomies of all the involved sutures in patients presenting with non-syndromic craniosynostosis. Presented herein, are the results of treating nineteen patients during the last 8 years with these techniques. *Patients and methods:* A total of nineteen patients, thirteen males and six females, presenting with multiple suture non-syndromic synostosis were included in this review. Fourteen patients had involvement of 2 sutures and five patients had 3 sutures involved. The overall sutural distribution was as follows: coronal 24; sagittal 10; lambdoid 5; metopic 4. A total of forty-three sutures were involved. Patients' age ranged between three weeks and seven months with a mean of 2.6 months. The patients weight range between 2.9 kg and 7.4 kg with a mean of 5.6 kg. Using the aid of zero and thirty degree rigid endoscopes, all of the involved sutures were isolated and resected. For those patients with sagittal suture synostosis, a wide vertex craniectomy was performed. Approach to the sutures was made through several 2 cm scalp incisions. All patients were treated with custom made surlyn helmets for up to twelve months following the procedure. *Results:* The overall surgical time ranged was between 38 and 150 minutes with a mean of 68 minutes. All patients were discharged on the first post-operative day. Estimated blood losses ranged between 10cc and 100cc with a mean of 41cc. When the patient blood volume was estimated, it ranged between 3.2 and 15.9% with a mean of 9.5%. Only one patient required an intraoperative blood transfusion and one patient had a transfusion following surgery and prior to discharge. All patients were monitored for the presence of venous air embolism using transcordial Doppler and none were detected. The mean pre-operative hematocrit was 30.4% (19.1% to 46%) and the mean met in the recovery room was 21.1% (17.8% to 38%). One patient had a one dural tear which was repaired endoscopically at the time of surgery. There were no post-operative CSF leaks or subgaleal fluid collections. There were no dural sinus injuries, hemorrhages, infections, visual or neurologic injuries. No patient has required re-operation. Although one of the original goals was to stop or slow down the progressive craniofacial deformity prior to definitive craniofacial vault remodeling, all patients have proceeded to gain mesocephaly and normalization of the presenting deformities. All patients tolerated post-operative therapy well and there were no skin related complications. *Conclusions:* Results indicate that early management of non-syndromic multiple suture synostoses can be safely and effectively done using endoscopic assisted craniectomies and post-operative cranial molding with helmets. Endoscopic assisted techniques provide the treating surgeon with an alternative method which have been found to have less surgical time, blood loss, transfusion rates and length of stay than conventional remodeling techniques. With proper patient selection and careful execution, the results of treating these patients with minimal invasive techniques can lead to excellent results. With proper patient selection and careful execution, the results of treating these patients with minimal invasive techniques can lead to excellent results.

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Endoscopic calvarial synostectomy in the management of craniosynostosis of the infant. K. Manwaring, S. Beals, T. Littlefield (Phoenix)

Objective: Surgical techniques for the management of synostosis by simple synostectomy were largely abandoned in the 1980's and replaced by more extensive cranial remodelling approaches to gain more consistent longterm improvement. With the advent of the cranial remodelling band (DOC band) we commenced minimally invasive approaches utilizing endoscopic visualization and guided

surgery beginning in 1994. *Patients and methods:* As a portion of this group we report a recent series of 44 consecutive endoscopic synostectomies for sagittal synostosis in infants less than six months. This is compared to a series of 102 open calvarial remodelling procedure performed by us previously. Surgeries were performed by 2.5 cm incision over the lambda and 2.5 cm incision over the bregma. Subgaleal dissection exposed the midline fused sagittal suture and entire parietal squames. Synostectomy in the subgaleal plane was performed with rongeurs, scissors, or a forward burring drill bit. Lateral parietal "barrel stave" releases were performed behind the coronal suture and in front of the lambdoidal suture. *Results:* Blood loss was typically in the 75-100 ml range. All surgeries were less than 1 hour. Patients were discharged home on days 1-3, mean day 2. Patients were placed in cranial remodelling bands 7 days post surgery and wore the bands 3-4 months to facilitate normalization of head shape. Mean age of surgery was 3.6 mos (1-7.5); mean head band treatment time was 3.5 mos (1.25-7.0 mos). Mean cephalic index (width/length ratio) improved from 64.8 to 80.2 (normal 70-85). This is a mean increase of 16%. The mild regression in index was noted over 12 months of follow-up to 0.75. Secondary abnormalities of bi-temporal narrowing and frontal bossing also dramatically improved. *Conclusion:* We judge the endoscopic synostectomy approach to be superior to more extensive calvarial remodelling on the basis of decreased operating time, minimal incisions, blood loss, total hospitalisation, and parental satisfaction. The cranial remodelling band is a necessary adjunct, however, to gain improved results compared to the more traditional open calvarial remodelling approaches.

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Endoscopic treatment of intracranial abscesses. P.L. Longatti, A. Perin, A. Fiorindi, F. Ettore (Treviso)

Objectives: Stereotactic puncturing and external draining gained wide acceptance as the standard treatment for intracerebral abscesses. Neuroendoscopy may be considered as a variant of this technique, with the advantage of a direct and precise inspection of the cavity and the possibility of an immediate washing of the purulent material. *Patients and methods:* From 1996 to 2003, four patients with cerebral abscesses and one with a subdural empyema were operated on with neuroendoscopic technique in our department. In all cases, symptoms related to mass effect and intracranial hypertension were present. Introducing a 4 mm flexible endoscope into the purulent lesion through a burr-hole, a meticulous pus aspiration and antibiotic washing of the cavity were performed, using the working channel both for irrigation and suction. In four cases a catheter was left inside the cavity for 3-7 days, in order to rinse with antibiotic solutions. *Results:* Post-operative CT-scans revealed a sufficient evacuation of purulent collections and capsular collapse in all the patients. There was neither mortality nor morbidity due to the procedure. Clinical evaluation at three months showed a complete regression of the previous neurological impairment in three cases and good recovery with a slight residual functional deficit in two. *Conclusion:* According to our experience neuroendoscopic treatment abscesses is a possible alternative to stereotactical evacuation, presenting some additional advantages such as the possibility of a complete evacuation of these lesions under direct view. The adoption of stereotactic or frameless pointing systems would probably be advisable, particularly for deep lesions.

18 June, Saturday: 12.30–14.00

Session 15

Future perspectives

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Should the term “minimally invasive” still be used? Neurosurgical language between science and advertising. A. Aschoff (Heidelberg)

Objective: Scientific language requires precision, unambiguity and a crystal-clear distinction between descriptive and normative fields. – The diffusion of terms and attitudes of commercial advertising into neurosurgery is a new trend. The “Gammaknife” contains lancet, “programmable” valves no computer, only a simple adjustable spring; a “StealthStation” is visible and no high-bomber. Surprisingly all these evident nonsense terms are meanwhile accepted in the best journals; however, the examples lead seldom to confusions. In contrast, the physically incorrect advertising-term “flow-controlled” valves, which are in reality controlled by pressure, confused even shunt-experts concerning the function of Orbis-Sigma-valves. In the eighties the term “minimally invasive” (MI) was launched in the world of health business’ and competitive commercial surgical and orthopedic institutions, not within science. Despite of the problematic origin and the missing definition many neurosurgeons adopted the term as a key-word of the decade into scientific publications around 1992. In the meantime the term MI became maximal popular in medical profit centers, the so-called alternative medicine and even in paramedical witchcraft. In this dubious neighbourhood the scientific use of MI is decreasing. – A discussion of the scientific status of the term MI is necessary. *Methods:* We analysed the origin and the empirical use of the term “minimally invasive” in neurosurgical publications and paramedical advertising. *Results:* MI has a double semantic: a descriptive for endovascular, endoscopic etc. procedures, and a normative closed to the ultimate aim of every medicine, “nihil nocere”. Unfortunately for science, but ideally for advertising MI is oscillating uncontrollably between these fields. In contrast to precise words implication, other methods are inferior. The declaration of a procedure as MI anticipates the empiric evaluation. A falsification (Karl Popper) is finally impossible. These properties clarify the evident extreme abusality of the term, which may be incorrigible. *Conclusion:* Suggestive, but incorrect words are tolerable in advertising, but not in science. MI is an oscillating and ambiguous term, extremely at risk for any abuse and delays/inhibits scientific evaluations. It should be avoided in science.

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Training the neuroendoscopist – should we establish requirements and/or certification. R. Abbott (Bronx, NY)

The use of the endoscope in surgical and medical subspecialties has matured and its application become much more sophisticated since Hopkins improved the design of the lens scopes, and developed fiber optic technology improving illumination and giving us flexible endoscopes. As the sophistication in use increased many specialties devised training requirements and certification processes to improve the level of safety in endoscopy in their respective fields. This presentation will review these requirements and processes by the subspecialty to frame the question is it time for neurosurgery to define the training requirements whereby a neurosurgeon could be certified as having been exposed to an adequate case load to be deemed a neuroendoscopist.

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Future perspectives and ergonomic aspects of a visual navigation system for neuroendoscopy. M. Scholz, S. Dick, B. Fricke, S. Tombrock, A. Harders (Bochum)

Objective: During the development of navigation systems trouble-free function of different moduls was always for. In comparison ergonomic aspects will be more important in the future due to the increasing intraoperative image techniques used in neurosurgery. The new developed VN (visual navigation) system uses previously stored endoscopic images for navigational purposes. *Material and methods:* A 5.9 mm rigid endoscope (Caemaert, Wolf Co.) was linked to an optical position management system. Calibrated endoscopic images together with 3D data of the current endoscope position were transferred to a personal computer with the developed VN (visual navigation) software. These images were sampled during the approach inside the ventricular system. The modules landmark tracking and measurements as well as virtual backmovement were tested simulating an operative situation in a human cadaveric model. Endoscopic approaches via burrhole were used. The neurosurgeon watches two monitors: one monitor with the real endoscopic image and one monitor with the image modified by the VN-software. *Results:* A typical learning curve was found with improvement in speed during usage of different modules. Number of mouse clicks as well as speech contact between neurosurgeon and engineer were analysed. The module measurements of structures showed no clear learning curve. Times for successful measurement were between 27.25 sec. and 131.2 sec. These informations were used for soft- and hardware modifications. *Conclusion:* Improvement and acceptance of navigation systems can only be reached by analysis of ergonomic aspects and stepwise improvement of hard- and software components. Intense training with navigation system is necessary for optimal usage of this equipment.

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Development and evaluation of a ventriculocisternostomy simulator. E. Strauss, C. Trantakis, H. Maas*, K. Cakmak*, U. Kühnappel, G. Strauss, A. Wagner, J. Meixensberger (Leipzig, Karlsruhe*)

Objective: To develop and evaluate a prototype ventriculo-cisternostomy (VCS) simulator. *Material and methods:* The software and hardware environment for a virtual interference were created. Special attention was applied for the development of a haptic control unit in line with standard usage. 35 test persons were examined with the developed simulator. 15 with operational endoscopic experience, the remaining 20 did not have any operational knowledge. Each test person completed a defined sample interference in a first cycle (10 times). After an exercise-free interval of one week another 5 exercise runs had to be absolved. In each case the parameters time, way (economy of hand movement), general errors and critical errors were judged. *Results:* The yielded data could be interpreted according to efficacy as follows: Each rehearsing achieved a significant learning effect, which could be seized qualitatively and quantitatively and was reproducible after the free interval. The surgical group learned faster in particular concerning the critical errors and achieved better results than the inexperienced group. There was no correlation between initial and final results. Thus it could be shown that there is a reproducible learning effect using this prototype. *Conclusion:* The “surgical group” profits from their operational experience. However, a prognosis about the latter manual abilities of a each particular group is not possible with the simulator.

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Virtual endoscopy for transsphenoidal pituitary surgery. S. Wolfsberger, M. Donat, A. Neubauer, K. Bühler, T. Czech, E. Knosp (Vienna)

Objective: Endoscopy is gaining increasing acceptance for the transsphenoidal approach to sellar lesions. For a safe application of this new technique, however, special training, and preoperative planning is mandatory. Virtual endoscopy (vE) allows a simulated three-dimensional visualization of anatomical structures by computerized reconstruction of radiological images. The aim of this study is to demonstrate the applicability of our recently developed vE prototype in the routine daily setting. Therefore, the system was enhanced by multimodality image fusion, segmentation of anatomical structures, visualization of deep structures using rendering. *Patients and methods:* vE was realized using a ray-casting plugin of a commercially available radiological software. The data for vE were derived from high resolution CT, MRI and MRA scans of all 20 patients with pituitary (17 macroadenomas, 3 Rathke's cleft cysts). After image fusion, the pituitary gland and tumor, internal carotid arteries, and optic nerves were segmented and displayed transparently during the preoperative virtual endoscopic approach. Underlying bone was displayed for identification of the sphenoid ostium and thickness of septations using volume rendering. Anatomical structures were identified on eV images and compared with the intraoperative endoscopic view. *Results:* vE was found particularly useful for the preoperative depiction of the nasal anatomy and its variations for choosing the side of the approach, the location of the sphenoid ostium, the sphenoid sinus septae and chambers for improved intraoperative orientation, the transparent visualization of the pituitary gland, tumor and adjacent vascular structures in relation to the sphenoid sinus landmarks for planning the opening of the sellar floor and tumor removal. *Conclusion:* According to our results, vE is a valuable tool for endoscopic pituitary surgery in terms of training purposes and preoperative planning in the routine clinical setting. Furthermore, eV can add to safety of interventions in case of anatomical variations.

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Augmented reality for neuroendoscopic interventions. D. Freudenstein, J. Fischer, D. Bartz, F. Stubenvoll, M. Neff, F. Duffner, M. Tatagiba (Tübingen)

Objective: Image-guided surgery (IGS) is the standard method for providing additional visual information and orientation to the surgeon. Such graphical representations are especially helpful for minimally invasive interventions. In the past years, the idea of transferring augmented reality (AR) techniques into medical applications has been tested in many experimental settings. One drawback of most of these experimental setups is their reliance on specialized hardware and display systems. These system components often prevent the transition of medical AR systems from a research state into the clinical practice. The reason for this is the fact, that these devices can require tedious setup procedures, take up a lot of space in the operating room, and can suffer from magnetic interference. We propose a novel system for medical augmented reality. *Material and methods:* We have developed a prototype augmented reality application, which receives virtually all data necessary for useful reality augmentation from a VectorVision IGS device. In our system, a standard webcam is used for acquiring a digital video stream. The webcam is tracked by the built-in infrared cameras of the image guided surgery device. In order to achieve the correct overlay of virtual graphical objects over the real scene, a transformation from the coordinate space of the IGS cameras to the webcam coordinate system is required. We have devised a one-time calibration step for computing this transformation. A specialized network based interface is used for the download of tracking information from the image guided surgery sys-

tem. *Results:* We have implemented an example application providing an overlay of anatomical data, including the actual current patient dataset, over the camera image. Moreover, graphical representations of tracked surgical tools can be displayed in the augmented view. We have found our application to be able to generate an augmented video stream at a steady frame rate of 15 fps. In addition to the standard display of graphical objects, we have devised a method for correctly handling occlusion by the patient anatomy. Our algorithm extracts a visual hull volume from currently displayed patient dataset and uses it as a phantom model for occlusion handling. *Conclusion:* Our design paradigm for medical augmented reality is to minimize the necessity of additional hardware components. We have achieved this by relying on commercial image guided surgery. Thus the transition of AR into the clinical practice could be facilitated.

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Spatial perception predicts laparoscopic skills on a virtual reality laparoscopy simulator. I. Hassan, M. Koller, B. Gerdes, P. Langer, R. Kress, M. Rothmund, S. Hörle, A. Zielke (Marburg)

Objective: Laparoscopic surgeons need to form visual impressions of 3-D structures from a two-dimensional video monitor. The aim of this study was to assess whether existing stereoscopic vision and spatial perception correlate with laparoscopic skills as evaluated on a laparoscopy simulator. *Methods:* 24 novices (12 inexperienced residents and 12 last year medical students) were enrolled in this study. The degree of stereoscopic vision of all participants was measured using the *TNO-Stereoscopic test*[®]. Also all participants performed a 3-D spatial perception-test (*Stumpf-Fay cube perspectives test*[®]). The existing of laparoscopic skills for both groups was estimated by the study, each participant completed the coordination task as "baseline" for assessment the existing laparoscopic skills. Then each participant performed a training program on the *LapSim*[®] consisting of 3 tasks of increasing difficulty (coordination, clip application and cutting). Both groups were tested again at the level of the cutting task. Time needed to complete the task as well as error rate were recorded. *Results:* All participants demonstrated the presence of stereoscopic vision. Participants with high degree of stereoscopic vision performed the cube perspectives test better than those with low degree of stereoscopic vision. Furthermore participants with high scores in 3-D spatial perception performed the "baseline" coordination task and the cutting task "endpoint measurement" faster and with less errors than those with lower, independent of existing limited laparoscopic skills. *Conclusion:* We suggest that the existence of a high degree of stereoscopic vision and spatial perception led to faster adaption to the 2-D; i.e. non-stereo environment of *LapSim*[®] and correlates with a higher level of laparoscopic skills. The assessment of existing spatial perception of novices may be important to develop adequate individually adapted training program.

Permanent poster presentations

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Endoscopic management of colloid cysts of the third ventricle. V. Ciubotaru, L. Tataranu, A. Albert (Bucharest)

Objectives: The authors report their experience in nine patients with colloid cysts of the third ventricle who underwent endoscopic resection. The purpose is to elucidate the safety and efficacy for endoscopic approaches to these lesions. *Patients and methods:* Between April 2000 and December 2004, 10 patients underwent endoscopic interventions for treatment of colloid cysts. 9 patients were treated using the neuroendoscopic approach, in one patient the neuroendoscopic intervention failed and the patient had to be operated by mi-

crossurgical resection via a transfrontal approach. From the endoscopically treated patients (6 female, 3 male) all were symptomatic, with headache being the most common complaint (7 patients). The lesions were larger than 5 mm in diameter and caused hydrocephalus in different degree. A rigid neuroendoscope was used combined with stereotactic guidance in the first two cases. The cyst contents was evacuated and the remaining capsule was coagulated. *Results:* The average follow-up was 25.2 months (range 1-57 months). Total aspiration of the cysts' contents was achieved in 7 cases, while residual cysts were revealed on postoperative MRI in 2 cases. Symptoms of all patients improved postoperatively. There was no mortality or permanent postoperative morbidity. One patient presented with an asymptomatic recurrence after 2 years. *Conclusion:* The endoscopic approach of colloid cysts has the advantage of direct tumor visualization, while being minimally invasive and is associated with low morbidity and good results.

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Neuroendoscopic treatment of an arachnoid cyst of the cerebellopontine angle associated with a Klippel-Feil syndrome in childhood: case report and overview of the literature. A. Cordoba, R. Alberti (Montevideo)

Objective: Arachnoid cysts of the posterior fossa are rare in childhood especially in the cerebello-pontine angle. Neuroendoscopic fenestration may contribute to treat that kind of deep-seated lesions in a minimally invasive man. *Patients and methods:* We present a 5 year- old female with a symptomatic left-sided arachnoid cyst located in the cerebello-pontine angle. The cyst was associated with a complex pathology of the cervical raquis (Klippel-Feil syndrome), which was successfully treated by neuroendoscopic fenestration. The advantages of minimally invasive access to the posterior cranial fossa are discussed.

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Endoscopic removal of a cerebello-pontine meningioma. E.R. Orlando, G. Trillo (Rome)

A meningioma with a diameter of 2.5 centimeters localised in the cerebello-pontine angle, mimicking a neurinoma (only symptom: tinnitus) has been completely removed by endoscopic controlled technique through a minimal craniotomy (2X1.5 cm) The patient was discharged after 4 days despite her insisting request to go back home the first day after the intervention.

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Endoscopic endonasal transsphenoidal surgery in clivus chordomas. Report of two cases. V. Ciubotaru, A. Albert, M. Irimia (Bucharest)

Objectives: Chordomas are uncommon tumours, arising from remnants of the primitive notochord and frequently located within the clivus. The location of the tumour determines the path of its growth, the associated anatomic structures involved, the clinic symptomatology and the surgical approach. *Patients and methods:* The authors report two cases of adult patients with clivus tumours who underwent resection of the lesions by endoscopic endonasal transsphenoidal approach. This approach was preferred because of location of the mass – in the midclivus and rostral clivus. An endonasal unilateral approach was used, performed via anterior sphenoidotomy through the sphenoid ostium, which permits wide visualization of the sphenoid sinus, including the clivus. This more direct approach provided an excellent view of the surgical field and allowed extended surgery. Histologically, the diagnosis of a chordoma could be confirmed in both patients. *Conclusion:* After a literature review, the authors present the possibilities of transsphenoidal endoscopy, its advantages and limitations.

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