

5th World Congress of the International Federation of Neuroendoscopy (IFNE), 31 May–3 June 2009, Athens, Greece

Pre-Congress Meeting of the Italian Section of Neuroendoscopy

Skull Base Tumours

Endoscopy-assisted anterior skull base surgery in a pediatric series

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Introduction: Transnasal transphenoidal endoscopy-assisted surgery (TTES) is currently considered the gold-standard treatment for several lesions of the anterior skull base in adults. Thanks to the development of dedicated instruments, most authors have started using this technique in children with good results. We present our experience with a pediatric series.

Material and Method: 9 children (4 males, 5 females) harboring sellar, suprasellar or clival tumours underwent TTES between 2006 and 2008. The mean age at surgery was 8.3 years (range: 4–14 years). The preoperative assessment included MRI and high resolution CT scan examination. All the children were treated by a two nostrils-two/four hands transphenoidal approach under frameless neuronavigation guidance. A dedicated rigid endoscope (0°–30°–45° optics) and a standard pediatric instrumentarium were used. **Results:** A gross total surgical excision of the tumour was obtained in 6 out of 9 children. According to the histological examination, a diagnosis of craniopharyngioma was made in 3 children, pituitary adenoma in 2, and Rathke's cleft cyst, chordoma, Langerhans cell histiocytosis and epithelioid sarcoma in each of the remaining children, respectively. CSF leakage occurred in a 12-year-old girl operated on for a ACTH-microadenoma causing a Cushing syndrome: the fistula was resolved by means of endoscopic repair of the sella turcica and transient external lumbar drainage. The other complication was transient acute hydrocephalus in a 4-year-boy operated on for a clival epithelioid sarcoma; hydrocephalus resolved after 5 days of temporary external ventricular drainage. A significant reduction of the duration of the postoperative stay was noticed compared with patients treated by a craniotomy approach. The postoperative clinical course appeared painless and more comfortable compared with traditional sublabial transphenoidal approach. All the children are currently alive and in good clinical condition.

Conclusions: This experience confirms the effectiveness of TTES also in children. The mini-invasive approach allows to significantly reduce the neurological and naso-facial morbidity. The main limits consist in the small size of the nostrils and in the frequently absent

pneumatization of the sphenoid sinus, making necessary the use of a pediatric instrumentarium other than pediatric optics.

Anatomical structures involved in extended endonasal approaches to the skull base

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The base of the skull offers two views, as two faces of the same medal: the superior (intracranial), more familiar to neurosurgeons; the inferior (extracranial), more familiar to otolaryngologists and head&neck surgeons. The endoscopic endonasal skull base surgery is a novel surgical technique that offers the possibility to approach the intracranial content from below and so requiring the contemporary perfect knowledge of the surgical anatomy of both the intracranial and extracranial skull base anatomy. From the nose and with the aid of the endoscope as the sole visualizing tool it is today possible to reach the anterior cranial fossa with the olfactory groove and the sphenoid-ethmoid plate, the middle fossa with the sellar and parasellar regions, the posterior fossa with the upper, middle and lower retroclival areas, down to the craniovertebral junction, avoiding the classical transcranial and craniofacial approaches. The olfactory groove is the more anterior region; it is a rectangular area of the cranial base demarcated by the lamina papyracea (orbital walls) laterally, the planum sphenoidale posteriorly, and the frontal sinus anteriorly. Such an area is divided by the perpendicular plate of the ethmoid, the lamina cribrosa medially and the ethmoidal labyrinth laterally. Via the posteriormost paranasal cavity, i.e. the sphenoid sinus, it is possible to get a panoramic view of the planum sphenoidale and the tuberculum sellae, with the possibility to perform a transphenoidal transtuberculum sellae approach to the suprasellar areas (suprachiasmatic, subchiasmatic, retrosellar and intraventricular), and the sellar and parasellar regions with the cavernous sinus. The retroclival and craniovertebral junction regions can be approached with a lower trajectory of the endoscope: while for the upper two-thirds of the clivus the transphenoidal route is usually sufficient, for its lower third and for the CVJ the removal of the vomer and the opening of the superior part of the rhinopharynx is needed.

Endoscopic endonasal transclival approach versus retrosigmoid approach to the clival and petroclival regions. Anatomical considerations

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Introduction: Unlocking the anatomical complexity of the clival and petroclival area is surgically demanding due to the depth, the adjacent major neurovascular structures, the proximity of vital perforators and the high anatomical variability. The surgical treatment of clival lesions, mainly those located intradurally and with a limited lateral extension, may be challenging due to the lack of a surgical corridor allowing for the exposure of the entire lesion surface. In this anatomic study we explore the feasibility of examining the clival/petroclival area and the cerebello-pontine angle through both the endonasal and retrosigmoid endoscopic routes, aiming to describe the respective degree of exposure and visual limitations.

Material and method: Twelve fresh frozen cadaver heads (12 specimens) were employed. The heads were positioned in the dissection Lab mimicking the semi-sitting position thus enabling the contemporary use of both endonasal and retrosigmoid routes. Arteries were injected with red latex; veins were not injected. Both sides in each head were dissected. Before and after each dissection, a CT study was performed to evaluate the bony landmarks.

Results: The comparison of the two endoscopic surgical views (endonasal and retrosigmoid) allowed to define three subregions over the clival area (cranial, middle and caudal levels) when explored through the endonasal route. Their definition was based upon the identification of specific anatomical landmarks limiting the bone opening through the endonasal route and on natural well-established corridors through the retrosigmoid route.

Conclusions: The present study has illustrated through different perspectives (endonasal and retrosigmoid) the anatomy of the clival and petroclival areas and that of the cerebello-pontine angle. The anatomical advantages and limitations have been considered in order to evaluate the appropriate selection of the each one of the above mentioned approaches. The comparison between these two routes may provide detailed and useful intraoperative information in case of staged or combined endonasal/retrosigmoid approach.

Microsurgery and endoneurosurgery: complementary techniques for minimally invasive transcranial approach to anterior skull base and sellar/parasellar tumours

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The increased experience with endoscopic techniques has recently allowed for more extensive application of combined endoscopic and microsurgical approaches determining an evolution of the concept and the practice of endoscope-assisted microsurgery. In particular under direct endoscopic vision it is possible to perform many surgical manoeuvres, using specifically designed instruments passed in surgical corridors alongside the endoscope, which can be fixed on a holder. In this way it is possible to realize a transcranial bimanual endoscopic technique (that can be defined “endoneurosurgery”), which allows for dissection and manipulation of structures that are not directly visualized under the operating microscope. Endoscopy has thus become complementary to standard microsurgery, and both techniques can be used in different phases of the same operation. This procedure can be used for intracranial tumours and vascular surgery, allowing a minimally invasive “key-hole” approach with reduction of cerebral tissue manipulation and traction. Regarding tumour surgery, these

kinds of approaches are particularly suited for deep seated and small tumours of the anterior cranial fossa, suprasellar and parasellar regions. The contribution of endoscopy to standard microsurgery is, in these cases, based on its ability to better identify and manipulate anatomical structures under limited viewing angles and behind corners, using angled endoscopes. The authors describe their experience with a combined endoscopic and microsurgical technique in 20 cases of cranial tumours: 4 craniopharyngiomas, 4 epidermoid and 12 meningiomas located in the anterior cranial fossa and in the sellar/parasellar region. The authors demonstrate the technical aspects of endoneurosurgery, its advantages and limitations with the help of video material.

Rathke’s cleft cysts: endoscopic transphenoidal treatment

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Introduction: RCCs are non-neoplastic cystic lesions of the sellar region. The symptoms are mainly due to the compression of the surrounding tissue and to the inflammatory reaction induced by cystic content leakage.

Material & Method: Between June 1998 and October 2008 49 patients affected by Rathke’s cleft cysts underwent a transphenoidal endoscopic approach at the Bellaria Hospital of Bologna. Referral symptoms were pituitary dysfunction, visual impairment and headache. The follow-up ranged between 4 and 103 months (mean 53 months).

Results: Headache, hyperprolactinaemia and visual impairment improved in all patients. Complications consisted of permanent diabetes insipidus (two cases, one of them presented preoperatively) and postoperative CSF leak (three cases requiring a plastic repair). One young girl presented with multiple recurrences. One patient presenting with a cystic recurrence underwent a further procedure and the histopathological diagnosis showed the transformation of the Rathke’s cleft cyst into a craniopharyngioma.

Conclusions: Rathke’s cleft cysts are cystic lesions of the sellar and suprasellar region which are increasingly diagnosed by MRI. Only symptomatic cases are to be operated. The endoscopic endonasal surgery is a well tolerated procedure, presenting low complication rate. Cases having a squamous metaplastic transformation should be strictly followed because they may evolve into a craniopharyngioma.

Transmaxillo-pterygo endoscopic surgery to the pterygopalatine and infratemporal fossa

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Introduction: The endoscopic endonasal approach has been used successfully in the last 10 years for the resection of benign lesions and more recently in selected cases of malign tumours. Moreover, the joint collaboration with other speciality (ENT, Neurosurgeon, Ophthalmologist, Maxillofacial surgeon), the use of devices such as the microdebrider, microvascular ultrasound Doppler probe, and the computer-assisted navigation have improved tremendously the possibility of tumour removal by means of the endoscopic technique. Pterygopalatine and infratemporal fossa (PPF and ITF) are two very small regions of lateral skull base that communicate with the middle cranial fossa, orbit, nasal cavity, oral cavity via six foramina and canals, through which many

important neurovascular structures reach and cross over FPP and ITF.

The expansive lesions of pterygopalatine and infratemporal fossa are traditionally approached with anterior and lateral microscopic open accesses. Only recently anatomic studies showing an anterior endoscopic endonasal approach have been published; these studies show the possibility of an endonasal endoscopic surgical management of these lateral skull base areas.

Materials and Methods: Between May 1996 and January 2009 at ENT department of Sant'Orsola-Malpighi Hospital and Neurosurgical Department of Bellaria Hospital in Bologna, Italy, 29 patients underwent transnasal transmaxillo-pterygo endoscopic surgery for tumours involving PPF and ITF regions. All patients were studied with MRI and/or CT scan. Patients with suspicion for vascular lesions were submitted to an angiography with selective embolization 24–72 hours before surgery.

Conclusions: Our experience shows that the transmaxillo-pterygo endoscopic approach (TMPea) is a useful surgical technique for the management of selective lesions involving the PPF and the ITF. In the management of complex diseases a combined TMPea and craniotomy and/or transfacial approach in the same sitting or in different time is mandatory. The selection criteria, limits and complications will be illustrated.

Midline Tumours

Contribution of neuro-endoscopy in the management of pineal region germinomas

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Introduction: Germ cell tumours account for more than 50% of the tumours in the pineal region. The most common subtype is germinoma. We present our experience in three adolescent males who presented with acute hydrocephalus and a mass in the pineal region.

Materials and Methods: All three patients (15, 14 and 16 years old boys) presented with headache, vomiting, blurred vision and upward gaze palsy. They underwent MRI of the head and spine and endoscopic surgery, in order to treat hydrocephalus, to attempt biopsy and to collect CSF for cytology and tumoral markers (AFP, β hCG).

Results: In the first patient, third ventriculostomy was uneventfully performed, but biopsy was considered too risky and not attempted, because the tumour was entirely sub-ependymal, without any emerging portion. CSF tumoral markers were absent; CSF cytology and MRI were negative for dissemination. The patient underwent microsurgical biopsy of the lesion through suboccipital transtentorial approach. Histological diagnosis was germinoma. The patient was sent to neuro-oncologists for chemotherapy. Following two cycles of carboplatinum, VP 16 and ifofosfamide (according to SIOP CNS GCT 96 protocol for “standard risk, not metastatic pure germinomas”), the lesion completely disappeared; The patient underwent radiotherapy. At three years follow up the patient is well and tumour-free. In the second patient both third ventriculostomy and biopsy had been performed during endoscopic approach. Histological diagnosis was germinoma. Following staging, the patient was assigned to standard risk, not metastatic, pure germinomas protocol. At two

years follow up the patient is well and tumour-free. Also in the third patient both third ventriculostomy and biopsy had been performed during endoscopic approach. Histological diagnosis was germinoma, and also this patient was enrolled for standard risk protocol. However following chemotherapy, a little fragment of the tumour is still present at follow up MRI. The patient is scheduled for microsurgical removal of the residual tumour before radiotherapy.

Conclusions: With current treatment modalities, cytoreductive surgery is not indicated in germinomas because of the sensitivity of these tumours to radiotherapy and chemotherapy. Endoscopic approach has become the procedure of choice. Further treatments, such as open surgery and tumour removal, radiotherapy and chemotherapy, will be scheduled according to tumoral markers, CSF cytology and tumour histology.

The role of transventricular neuroendoscopy in the management of suprasellar tumours in children

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Introduction: Management of suprasellar tumours in children, above all craniopharyngiomas (CP) and optic pathways gliomas (OPG), is problematic and often requires multimodal protocols to achieve long term control of the lesion.

Clinical materials and Methods: We report 4 cases of craniopharyngiomas in which various endoscopic procedures have been performed. In the first case the endoscopic approach alone allowed the gross total removal of an intraventricular craniopharyngioma; in the second case the endoscopic fenestration of a cystic intraventricular craniopharyngioma allowed long term control of the tumour with no further treatment; in the remaining two cases endoscopic fenestration and drainage of the cystic part allowed collapse of the cysts with resolution of mass effect on the visual pathway and control of hydrocephalus. These patients later underwent microsurgical removal of the solid portion of the tumour. We report also 2 cases of suprasellar OPG: in the first case, with acute biventricular hydrocephalus at presentation, endoscopic marsupialization of the cystic portion of the tumour allowed control of hydrocephalus and decompression of visual pathway. Endoscopic biopsy of the cyst wall was not diagnostic. One week later, the patient underwent microsurgical subtotal removal of the tumour and then was assigned to neuro-oncologists. In the second case endoscopic ventriculocystostomy was performed 3 years following diagnosis of OPG (microsurgical biopsy performed at another centre) because of symptomatic progression of the cystic portion of the tumour despite chemotherapy.

Conclusions: Neuroendoscopy has shown great versatility in the management of intra or paraventricular CP and OPG. It can be used on emergency basis to drain the cyst, reducing the mass effect on the hypothalamus and visual pathways, and to control the eventually associated hydrocephalus. Wide marsupialization of cystic tumours into CSF spaces may allow long term control of the mass effect without further treatment. The endoscopic decompression of the cystic portion of mixed tumours may facilitate later definitive surgical approach to the solid portion. In some selected cases of purely intraventricular CP gross total removal of the tumour may be achieved through a purely endoscopic approach.

Endoscopic approach may also be considered an option in case of symptomatic progression of residual tumours.

Endoscopic biopsy of a rare case of adult PNET of the pineal region. Case report

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Introduction: Tumours of the pineal region comprise approximately 0.4–1% of all intracranial tumours in adults patients. At 2000 have been reported only 11 cases of cerebral PNETs in adults. The 4th edition of the WHO Classification of Tumours of the Central Nervous System major subsections redefined CNS/supratentorial PNET, including also neuroblastoma, ganglioneuroblastoma, medulloepithelioma, and ependymoblastoma.

Material and Methods: We report the case of a 60-year-old male patient with a brief history of diplopia and headache. The brain magnetic resonance (MR) displayed a difficult-to-diagnose enhancing lesion of the pineal region within the posterior third of the third ventricle with corpus callosum involvement. The tumour was resected through a pure transventricular endoscopic approach, with stereotactic coordinate route and consecutive third ventriculostomy. The histopathological diagnosis of PNET was obtained after re-examination by a referential neuropathological institute. Postoperatively, the patient received radiotherapy.

Results: At 2-year follow-up, there are no signs of tumour regrowth.

Conclusions: Diagnosis of pineal parenchymal tumours in general and PNETs in particular can be difficult. The adult PNET are uncommon entities and should be enclosed in the differential diagnosis of pineal region tumours. Due to the complexity of the histopathological features we recommend a multidisciplinary approach for planning the management of those neoplasms.

Endoscopic biopsy for pineal region lesions

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In the last two decades the use of the modern endoscopic techniques has changed the approach to treating intraventricular tumours: on a diagnostic level neuroendoscopy can be used for a safe biopsy while an endoscopic removal of the tumour can be realized in selected cases of small and/or cystic lesions. The advantages of endoscopic biopsy consist on direct vision of the lesion, which allows: a) the choice of the biopsy area, therefore improving the diagnostic efficacy, b) the possibility of haemostasis and c) the choice of a safer trajectory in order to protect the normal anatomic structures; furthermore endoscopy permits the simultaneous treatment of associated hydrocephalus by means of a third ventriculostomy. In cases of clear anatomic landmarks, free hand endoscopic biopsy is today currently an alternative to stereotaxy, while when no clear anatomic landmarks exist (i.e. distortion of normal anatomy, haemorrhage) and/or in case of small ventricles endoscopy can be associated with neuronavigation or eventually with stereotaxy. From 1994 to 2008 we have treated endoscopically 14 patients 6 females and 8 males, aged between 14 and 75 yrs of age with tumours in the pineal region. Endoscopic biopsy was planned in order to decide on treatment to be undertaken. From a technical point of view we used flexible endoscope, for anatomical reasons and to perform the biopsy and a third ventriculostomy

through a single trajectory. Whenever possible we took at least three biopsy specimens, in different areas, controlling the frequent minor bleeding with irrigation and/or mild compression with a balloon, and only exceptionally with a low-power coagulation. We advise performing the biopsy, before the third ventriculostomy, in order to prevent blood contamination of the interpeduncular cistern. The results in this series were satisfactory as an histological diagnosis was obtained in 12 of 14 cases (85.7%): there were 4 germinomas, 3 pineocytomas, 1 pinealoblastomas, 1 high grade glioma, 1 teratoma and 2 pineal cyst. Five patients underwent a subsequent microsurgery, while in 5 cases radiotherapy was performed. The third ventriculostomy resolved the hydrocephalus in 12 cases. In the other two cases a shunt was inserted. The complications consist on a major intraventricular haemorrhage, which required surgical evacuation. No mortality or permanent morbidity was observed in this series, showing that neuroendoscopy is a safe minimally invasive biopsy-approach for pineal tumours with a highly successful diagnostic rate, and this is in accord with the pertinent literature.

Endoscopic transeptal-interforniceal approach to IIIrd ventricle colloid cysts

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The authors report two cases of large third ventricle colloid cysts mostly located in a retroforaminal position, occluding both foramina of Monro, extending up through the roof of the IIIrd ventricle inside the septum pellucidum. The cyst distended the interforniceal raphe development so the two fornices and internal cerebral veins were split apart by the lesion expansion. The cyst was approached with a rigid neuroendoscope, through a pre-coronal burr hole, 2.5 cm lateral to the midline (Kocher's point). Following a transventricular route, the right leaf of the septum pellucidum was opened posterior to the septal vein. The interforniceal raphe was dissected to reach the upper wall of the cyst. The cyst was evacuated and the wall partially removed or coagulated. The post-operative course was uneventful and the patients discharged home in third post-operative day with complete relief of preoperative symptoms. The authors describe and discuss the approach.

Cystic craniopharyngioma: the role of the endoscopic ventriculo-cysto-cisternostomy

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Microsurgical total removal is the gold standard in the treatment of craniopharyngiomas. However, due to the intimate relationship with delicate neurovascular structures and absence of cleavage this result is often burdened by incapacitating endocrinological and neuropsychological sequelae. A predominantly cystic lesion is observed in 60% of craniopharyngioma patients. In consideration of the biologically benign nature and evidence that mass effect rather than infiltration is responsible for symptoms, cyst drainage seems an acceptable compromise in most cases, especially in recurrences and elderly patients. In the last decade neuroendoscopy has been increasingly used and has shown great versatility

both as sole procedure or as a step of a multimodal protocol. Cysts impinging on or growing into the ventricular system (Yasargil's C to F types) are suitable for an endoscopic approach. Different techniques have been proposed ranging from gross total removal to palliation for control of hydrocephalus prior to microsurgery. In our experience cysto-venticulo-cysternostomy (i.e. wide marsupialization of the cyst in the ventricles and basal cisterns) is the procedure of choice as it has proven safe, effective in the control of tumour in the long-term and easily repeatable.

Material & method: The procedure, conceptually based on the classic stereotactic work of Spaziante and deDivitiis, is carried out through four basic steps: 1) standard pre-coronal parasagittal approach to the lateral ventricle; 2) identification and puncture of cyst's dome and complete drainage of content by washing with Ringer's solution; 3) coagulation and resection as extensive as possible of cyst's dome; cavity exploration, biopsy; 4) perforation of cyst's fundus into basal cisterns. We also emphasized the "stenting" of the cyst (i.e. transcystic positioning of a multi-holed catheter) as an effective measure to ensure CSF circulation and prevent re-filling, even in case of reclosure of the marsupialized cavity. All manoeuvres with special reference to steps 3) and 4) must be carried out only after clear identification of anatomical landmarks; in case of excessive distortion of the latter by craniopharyngioma the procedure should be limited to cyst drainage.

Results: In our series a complete drainage was achieved in all but one patient, due to an unaccessible pouch separate from main cavity. Mean surgical time was 126 min. There were no intraoperative complications and no cases of chemical meningitis were observed. Mean hospital stay was 6 days. One case of recurrence and one enlarging, previously undrained pouch where successfully re-endoscoped. Our first patient harbouring a giant cyst died of a brainstem glioma 7 years after endoscopy, totally free of recurrence.

Conclusions: We believe that radical resection should not be the goal of neuroendoscopic approach to cystic craniopharyngiomas while control of mass effect, preservation of the function and integration with other therapeutic means (microsurgery, radiation therapy, radiosurgery) surely are. Further experiences and longer follow-up is needed in order to address two main issues: recurrence rate and possible CSF seeding. Recurrence rate is undetermined due to small numbers and lack of homogeneity but seems unrelated to neuroendoscopic aggressiveness. Systematic cysternostomy and internal cyst stenting creates an additional outflow route to the intracystic CSF circulation and can limit the need for further procedures. Remote recurrence of craniopharyngiomas has been related to intraoperative transplant or CSF spreading and therefore cysto-venticulo-cysternostomy should in theory be at risk. However seeding represents an exceptional event and all reported cases occurred after open surgery were manipulation of solid, more cellular tumour is maximal. No such event has been reported to date in the neuroendoscopic literature. Neuroendoscopic approach represents a major advance compared to classic draining techniques since emptying is obtained under direct vision and operativity of the instrument allows a partial resection of the capsule for diagnostic purposes and wide marsupialization. Perforation into basal cisterns and stenting are measures to prevent reclosure and recurrence and other therapeutic modalities (microsurgery, radiosurgery, fractionated external radiation ther-

apy) can be later scheduled to eradicate solid remnants, if indicated. Case selection must be based on anatomico-surgical (cystic/solid rate, Yasargil's type) and clinical (primary/recurrent, age, conditions) considerations: in such cases, as tumour control and satisfactory reintegration into the appropriate social setting are the goals, endoscopy cannot be ignored.

Ventricular Tumours

Endoscopic surgery for intraventricular tumours

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Neuroendoscopy reflects the actual trend of neurosurgery toward minimally invasive procedures. This technique allows reaching the lesion respecting the surrounding anatomical structures, to perform multiple biopsies under visual control, to perform a third ventriculostomy for the treatment of hydrocephalus, with a single procedure and with lower incidence of complications. We believe that the role of neuroendoscopy is well-defined in the treatment of cystic tumours. The usefulness in solid neoplasms is often limited to biopsies. The complete removal of tumour is possible only in particular circumstances: small lesions, not hypervascularized. We report our experience with intraventricular tumours (28 patients) treated by endoscopic surgery: colloid cysts, pineal region tumours, solid and cystic tumours of the third ventricle, para-ventricular tumours.

A restricted neuroendoscopic approach for pathological diagnosis of intraventricular and paraventricular tumours

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Introduction: Neuroendoscopic techniques are achieving growing interest in neuro-oncology, with aims and results to some extent comparable to traditional surgical techniques (microsurgery and stereotaxy). We report our experience in order to attempt the definition of stricter criteria for indication to cerebral endoscopic biopsy in patients harbouring intraventricular and paraventricular brain tumours.

Material and Methods: We report our Institute's experience with 23 patients (aged 7–78 years) who underwent endoscopic biopsy for intraventricular or paraventricular lesions considered not suitable for surgical removal and too risky for a stereotactic approach. All the samples were obtained using a flexible endoscope with the free-hand technique.

Results: In 16 cases specimens were adequate and led to diagnosis; in 3 cases they were significant but not completely diagnostic; a pathological diagnosis was unavailable in 4 cases. In 13 patients with a lesion causing an obstruction of the aqueduct, a third ventriculostomy was performed during the same procedure; in one patient harbouring a lesion occluding the Monro foramen, a septostomy was done, while in another case multiple cystostomies were required. No relevant complications were observed, either clinically or radiologically; in particular no major bleeding occurred.

Conclusions: In our experience, endoscopic biopsy could provide a pathological diagnosis in 19 out of 23 cases. We believe that endoscopic biopsy should be considered as the first choice in selected cases of lesions that are otherwise difficult to approach. We suggest to sample large amount of tissue as this is the key to biopsy success and does not seem related to an increased bleeding risk.

Endoscopic laser treatment of intraventricular lesions

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Introduction: From the beginning of our neuroendoscopic experience we have used diode laser to perform coagulation of choroid plexus, to control bleeding, to perform resection of intraventricular lesions.

Materials and methods: 22 intraventricular lesions have been treated by an intraventricular endoscopic laser-assisted technique (6 colloid cysts of the third ventricle, 5 craniopharyngiomas with intraventricular extension, 1 lateral ventricle cavernoma, 8 pineal gland tumours, 2 gliomas).

Results: No complications directly related to the use of laser occurred. About colloid cysts we have had no cases of recurrence, and hydrocephalus has been always controlled. In craniopharyngiomas the endoscopic endoventricular technique has been useful to control the intraventricular extension and for a minimally invasive resection. The resection of cavernoma has been successfully completed en bloc. For the biopsies of pineal gland tumours the laser allowed a easier control of minor bleedings; we reached always the histological diagnosis and the control of the related hydrocephalus by endoscopic third ventriculocisternostomy.

Conclusions: We found that laser (diode laser) is safe and useful to coagulate the choroid plexus, to resect tumours or to perform fenestration of cyst wall, with sensible reduction of surgical time in comparison to bipolar coagulation alone.

The role of neuroendoscopy in multimodal management of pediatric brain tumours. Analysis of 74 patients

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Aim: To investigate efficacy and safety of neuroendoscopic management of brain tumours.

Materials and methods: Since 1994 to 2008, 74 patients underwent neuroendoscopic surgery for brain tumours; 37 males, 37 females, mean age 12.2 years with mean follow-up 4.1 years; NF1 and TSC coexisted in seven and five cases respectively. Twenty-two patients (30,9%) did not show hydrocephalus at admission. Tumour sites were basal ganglia-lateral ventricle (25), suprasellar region-third ventricle (23), optic pathways (19), brainstem (5), pineal region (1), and fornix (1). Surgery was free-hand and performed by 9.5Fr rigid and 30° optic angulated endoscope; neuronavigation system was coupled in case of small ventricles or complex trajectories. In 46 cases neuroendoscopy was first-choice surgery, in 37 integrated microsurgery. Three patients underwent multiple endoscopic procedures.

Results: Endoscopic surgery was tumour cyst fenestration and drainage (26), biopsy (25), partial (17) and total removal (14), hypothalamic hamartoma disconnection (6); Ommaya reservoir insertion was coupled in 19 cases; ETV and/or septostomy were associated in case of hydrocephalus. Four patients had diffuse gliomatosis cerebri. Histology was Low-Grade-Glioma (28), craniopharyngioma (11), hypothalamic hamartoma (6), germinoma (7), High-Grade-Glioma and SEGA (5), cavernoma and CSF seeding of medulloblastoma (3), sarcoidosis (2), AVM, choroid plexus tumour, subependymoma, and neurocytoma (1). Surgical morbidity (7%) and mortality (1.4%) were due to intraventricular haemorrhage (2), surgical forceps breaking (1),

aseptic meningitis (1), malignant and fatal oedema in gliomatosis (1). In thirty patients (40.5%) neuroendoscopy was exclusive surgery followed by chemo-radiotherapy and/or brachytherapy. In thirty-eight cases (51.3%) it was usefully associated with microsurgery, in six (8.2%) was not efficacious in tumour management. At last follow-up, 38.7% of all patients carry a VP-shunt, near to half of hydrocephalic patients at presentation.

Conclusion: Exclusive neuroendoscopy is efficacious and safe to remove smaller intraventricular lesions (craniopharyngioma, cavernoma, CSF metastasis, SEGA), and tumours highly radio- and chemoresponsive (germinoma). In bigger lesions, it may facilitate microsurgery to reduce tumour mass and control hydrocephalus (craniopharyngioma). Thanks to low morbidity, neuroendoscopy is a valid tool in long-term management of deep LGG. In many cases with hydrocephalus at presentation, it avoids persistent shunt devices. New technologies are needed to improve neuroendoscopic tools.

Videoneuroendoscopy vs. fiberneuroendoscopy: our experience

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Background: The target of this paper is to show the optimized vision in neuroendoscopy by a “new” optic system: the videoendoscopy. The discussion is always open between the followers of steerable fiberscope and the followers of rigid lens-endoscope. All scientific groups use the endoscopic instrument more comfortable to their manuality, but it is clear that the rigid lens endoscope shows the top quality of optic vision, although the steerable fiberscope allows more operativity in small anatomic sites like cerebral ventricles.

Aim and Methods: We discuss the technological development of miniaturized optic instruments, aiming to find a system that targets the top quality of optic vision and the top operativity. We have been advantaged by the development of industrial boroscopy that allowed us to follow the evolution of optic vision in other surgical areas. The technology of gastroscopy, colonoscopy, laryngoscopy and bronchoscopy (chip of 14–16 mm) weren't usefull to the needs microneurosurgical endoscopy. A more miniaturized chromatic chip with higher optic definition was needed.

Results: A new instrument is planned, related to the requirements of the top optical vision and the top operativity in small anatomical sites. The study is based on an experimental pathway of 3rd-ventriculostomies performed by neuroendoscopy with lens endoscope and each one was checked by (steerable) videoendoscopy (video-bronchoscope Olympus).

Conclusions: This experience evidenced critically the advantages of videoendoscopy that show the best relationship between optic vision and “steerability” combined in a single instrument.

Tu solid state laser and radiowave microfibre in neuroendoscopy of ventricular tumours

P.A. Oppido, F. Cattani, E. Morace (Rome, Italy)

Introduction: Neuroendoscopy is presently considered a minimally invasive surgical approach. Despite wonderful magnification of the endoscope, due to the minimally surgical approach bleeding control and tumour ablation are harmful by standard tools. Specially, in vascularized tumours and near vital structures the traditional electrosurgery can be ineffective and dangerous. In

neuroendoscopy the ideal tool is one thin handpiece for easy coagulation, cutting and ablation by preserving healthy tissue. Since 2007, we are using the Tu diode pumped solid state (DPSS) laser (Revolix, LISA laser products) and the high frequency radio wave (SurgiMax, Ellman innovations). In neuroendoscopy both the instruments can be used by thin microfibers through the endoscope's work channel.

Methods: In the Tu DPSS the active laser material is thulium (Tu), emitting light at wavelength of 2,0 micron, through one microfiber large 0,2 mm in diameter. The energy can be absorbed by water without side effects. This laser can hit the tumour in near contact or targeting from short distance with limited penetration. Tumour cutting and ablation is possible, too. The SurgiMax generates high frequency radio wave with low temperature, precise cutting or coagulation. The microfiber is large 1 mm in diameter and produces two electromagnetic radio waveform or 1,7 MHz or 4 MHz. Both the Tu DPSS laser or the SurgiMax radiosurgery work very well in water solution, as the CSF. We report our experience in 20 neuroendoscopic procedures for ventricular tumours by flexible and rigid scope.

Results: in 6 neuroendoscopic biopsies the Tu DPSS laser microfiber was used for haemostasis and partial ablation. In two cases septostomy through infiltrated septum was successfully performed. In one case 3rd ventricular nodule was totally removed by ablation with the laser. In 14 neuroendoscopic procedures for ETV or tumours cyst fenestration the SurgiMax radiowave microfiber was used. It showed precise coagulation at low temperature without tissue sticking. In all surgical procedures bleeding control was easy and successful. During laser activation endoscopic vision was always clear. No side effects due to these instruments were observed.

Conclusions: We consider Tu DPSS laser and SurgiMAX radiowave extremely easy to handle and safe. The laser is more efficient for coagulation and ablation of vascularized tumours. The radiosurgery provides more precise and controlled haemostasis of soft tissues.

5th World Congress of Neuroendoscopy

Hydrocephalus

Mobile neuroendoscopy as an outreach service-A Kenyan approach

M. M. Qureshi (Nairobi, Kenya)

Rates of Hydrocephalus in the paediatric population are disproportionately high in many countries in sub-Saharan Africa. The method of treatment has been the placement of VP shunts. This is available at few selected institutions which serve, at most, a quarter of the patient population that requires treatment. Shunts are expensive and therefore unavailable for a large majority of patients. In those who manage to receive treatment, shunt malfunction, blockage, infection, exposure, extrusion are attendant risks in up to 25% of cases. The overall morbidity and costs are especially high in such patients. Neuroendoscopic Third Ventriculostomy (ETV) is widely acknowledged as the appropriate method of treatment for patients presenting with obstructive hydrocephalus. Using a single portable neuroendoscope, an

outreach program has been developed by a team of Kenyan Neurosurgeons. The experience of ETV procedures in 177 patients spread over 14 hospitals in 4 East African countries, using the same equipment, is described as a viable, safe and cost effective option, that enables this current management and technology to be applied in resource challenged settings.

Endoscopic third ventriculostomy for hydrocephalus complicating brain infections in children

L. Padayachy, A.G. Fieggen, A.A. Figaji (Cape Town, South Africa)

The role of endoscopic third ventriculostomy (ETV) for hydrocephalus of infectious etiology is at present unclear. By far, the largest experience with post-infectious hydrocephalus is from a Ugandan series, in which young age did not diminish the success of the procedure, and the results were very favorable. However, this is not necessarily the experience in other centres, including our own anecdotal experience. There are several potential reasons for this difference, but very little has been published from other centres. Furthermore, it is unclear whether it makes a difference if ETV is performed in the acute phase or in the post-infectious phase of the illness. In this retrospective study of prospectively collected data, we examined 42 children who had confirmed brain infections leading to hydrocephalus that was treated with ETV. Data collected included the indication for surgery, clinical features, the diagnosis of infection as the underlying aetiology, computed tomography features, endoscopic findings, and subsequent clinical and radiological course. We will present our findings with regard to success rate and the analysis of the relationship between pre-operative factors and the likelihood of ETV success.

Audit of outreach neuroendoscopy in Kenya

P.K. Wanyoike, D.O. Olunya, M.M. Qureshi (Nairobi, Kenya)

Introduction: We present an audit of 177 cases of outreach cranial neuroendoscopy in Kenya. Setting: state, private, mission and provincial hospitals in Kenya.

Method: the cases were performed using the portable telepac and the Oi neuroendoscope. Data were collected from our operating record books and subjected to simple analysis.

Results: males were 61% (107) compared to 39%(70) female; 159 cases were etv, 10 cyst fenestrations, 7 tumour biopsy and 1 craniopharyngioma cyst drainage.

Challenges: meningocele and post meningitic hydrocephalics, non acceptance of procedure, initial high cost of equipment.

Conclusion: outreach neuroendoscopic third ventriculostomy is the best alternative for managing hydrocephalus in poor resource settings.

Using the ETV success score to compare success of endoscopic third ventriculostomy versus cerebrospinal fluid shunt

A.V. Kulkarni and collaborators for the Canadian Pediatric Neurosurgery Study Group (Toronto, Canada)

Introduction: We recently developed and validated the ETV Success Score (ETVSS) - a simple scoring system that predicts the 6 month success rate of ETV for a child with hydrocephalus, based on their age and etiology of hydrocephalus. The ETVSS ranges from 0 to 90 and the numerical score roughly equals the percentage chance that an ETV will be successful at 6 months

(e.g., an ETVSS of 70 means there is a roughly 70% predicted chance of ETV success). In this study, we explored the utility of the ETVSS by comparing the longer term success of ETV to shunt, within strata of ETVSS (low, moderate, and high scores).

Methods: A multicenter, international cohort of children (≤ 19 years old) with newly diagnosed hydrocephalus treated with either ETV ($N=489$) or shunt ($N=647$) were analyzed. ETVSS was calculated for all patients and the cohort was divided into those with high ETVSS (score >80 , $N=357$), moderate ETVSS (score $50-70$, $N=384$), and low ETVSS (score ≤ 40 , $N=395$). Survival analysis for time to treatment failure using Kaplan-Meier and Cox regression techniques was performed within each ETVSS group.

Results: In patients with a high ETVSS (score >80), ETV clearly performed better than shunt at all points in the postoperative follow-up. In the moderate ETVSS group (score $50-70$), shunt survival appeared to be marginally superior to ETV survival until about 24 months, at which point the survival curves crossed. In the low ETVSS group (score ≤ 40), shunt survival was clearly superior to ETV survival at all time points.

Conclusions: Patients with high ETVSS (>80) not only have a high chance of early success with ETV, but also superior longer term success compared to shunt. Patients with moderate or low ETVSS experience either equivocal or no benefit in treatment survival compared to shunt.

Trans-fourth ventricular aqueductoplasty and stenting in isolated fourth ventricle

Y. Ersahin, T. Turhan (Izmir, Turkey)

Introduction: The isolated fourth ventricle (IFV) is caused by occlusion of outlets of fourth ventricle. The most common aetiologies of obstruction to outflow of the fourth ventricle are infection and haemorrhage. Fourth ventricular shunts have been replaced by endoscopic aqueductoplasty and aqueductal stent in recent years. However it is almost impossible to perform aqueductoplasty and stenting in patients with slit ventricles and IFV. We report on two patients with IFV in which trans-fourth ventricular aqueductoplasty and aqueductal stenting were carried out.

Technique: Under general anesthesia, the patient is positioned prone with the head flexed on a horseshoe frame. After the patient is prepared and draped, a 2-cm paramedian incision is done in the left suboccipital area. A burr hole is made and the dura is cauterized. The cystic fourth ventricle is punctured with a peel away sheath, and then the Oi Handy-Pro rigid endoscope is introduced in to the fourth ventricle. A stent is placed in the aqueduct following endoscopic aqueductoplasty.

Case 1: a 6-year-old girl who had been shunted for post-meningitic hydrocephalus presented with head tilt and occasional urinary incontinence for the past 3 months. On neurological examination, head tilt, bilateral cerebellar signs and absence of gag reflex were determined. CT and MRI revealed slit supratentorial ventricles and dilated fourth ventricle. Trans-fourth ventricular endoscopic aqueductoplasty and aqueductal stent placement was performed. In the postoperative period the patient's symptoms and signs improved remarkably.

Case 2: a 2-year-old girl presented with right sided squint for the past 2 weeks. She was shunted for post-hemorrhagic hydrocephalus at the age of 1 month. She had no problems with shunt until

2 weeks ago. A right abducent nerve palsy, slight psychomotor retardation and bilateral Babinski signs were determined on neurological examination. CT and MRI revealed slit supratentorial ventricles and dilated fourth ventricle. Trans-fourth ventricular endoscopic aqueductoplasty and aqueductal stent placement performed. Abducent nerve palsy totally improved in a week postoperatively.

In conclusion, trans-fourth ventricular endoscopic aqueductoplasty is an effective method in the management of IFV in patients with slit-like ventricles. Aqueductal stent should be added to this procedure to prevent the restenosis.

CSF distribution changes after endoscopic third ventriculostomy in children

F. Di Rocco, A. Herbrecht, S. Puget, T. Roujeau, N. Boddart, F. Brunelle, D. Renier, M. Zerah, C. Sainte-Rose (Paris, France)

Object: The aim of this prospective study was to analyse the changes in CSF distribution after endoscopic third ventriculostomy (ETV) and to correlate these modifications with the clinical results.

Patients and methods: Twenty children (12 boys, 3 months to 14 years) operated on by ETV from January 2006 to September 2007 in our institution, were studied by a preoperative brain Magnetic Resonance (MR) and several postoperative MR scans at established time intervals (D1, D3, D15, D60). A volumetric analysis of CSF distribution was performed using the specific software Volume Viewer from General Electric®. ETV performed in posterior fossa tumors were excluded from the study.

Results: A progressive reduction of the volume of the ventricles (40%) was found in 18 children after surgery during the follow-up period. This finding was associated with an enlargement of subarachnoid spaces in 16 of them ($>200\%$). These results correlated with a good clinical response. The most contributive MR seemed to be the D3 one. Five children required a redo ETV during the follow-up period due to a secondary closure of the stoma which was associated with an augmentation of the ventricular volumes and reduction of the subarachnoid spaces at MR. These changes could be reversed by performing a new ETV. A sixth child who presented these changes in intra and extraventricular volumes without clinical changes died for an acute intracranial hypertension. The last two children of this series did not respond clinically to the ETV and have been shunted. Their ventricular volumes had increased without significant changes in the extraventricular CSF volumes at MR.

Conclusion: The MR shows the CSF displacement from the ventricles to the subarachnoid space after a successful ETV. In case of secondary closure of the stoma, the distribution of intra and extraventricular CSF tends to go back to the preoperative state. This finding suggests that MRs should be regularly performed during the follow-up of ETV to early recognize the patients at risk of secondary closure and lead to a surgical treatment before their clinical worsening.

The role of endoscopic third ventriculostomy in the management of acute shunt malfunction

C. Ruggiero, P. Spennato, F. Aliberti, V. Trischitta, G. Cinalli (Napoli, Italy)

Object: To evaluate the effectiveness of endoscopic third ventriculostomy (ETV) as an alternative to shunt revision in the management of acute shunt malfunction in children with hydrocephalus.

Methods: 45 hydrocephalic patients presenting at our department with symptoms and signs of acute malfunction between January 2000 and December 2008 were treated with ETV, shunt removal and continuous ICP monitoring for 8 days following the procedure. The aetiology of hydrocephalus was aqueductal stenosis (13), myelomeningocele (7), meningitis (2), arachnoid cyst of quadrigeminal plate (1), intraventricular haemorrhage of prematurity (13) and malformative (9).

Results: in three cases (two lumbar myelomeningocele and one aqueductal stenosis) perforation of the floor was considered too dangerous because of significant anatomical modifications. In these patients the procedure was abandoned and the shunt was revised and left in place. In 42 cases ETV was successfully performed; 29 of them showed normal ICP value at postoperative ICP monitoring and are now shunt free with a mean follow up of 4 years. 13 of them showed progressive increase of ICP values and increase of ventricular dilatation on CT scan and were implanted with a new shunt. No morbidity or mortality related to the procedure was observed.

Conclusion: our experience seems to confirm the effectiveness of ETV in the treatment of acute shunt malfunction in selected cases of obstructive hydrocephalus. Further studies are required to identify the ideal candidates and avoid unnecessary procedures.

Unusual indications for ETV

J.A. CostaVal (Nova Lima, Brazil)

Introduction: Usual indications for ETV, obstructive hydrocephalus for aqueductal stenosis, tumoral obstruction or non tumoral obstructions are well defined and the indications are clear. However, a lot of discussion already exists over unusual indications. We tried to analyze and better understand those situations.

Material & Method: We analyze our personal series of about 300 ETV performed in 9 years. We defined as unusual ETV due to unusual pathologies - Chiari II, neurocysticercosis and dementia; and unusual situations - very young child, infections and narrow ventricles. On the situations where we had a good cause, we tried to conclude what are the results and the efficacy. In the other cases, we just express our personal opinion.

Results: Chiari II was the most prevalent. We could conclude that is a difficult technique and the better results are in the old children. Neurocysticercoses should be tried if the image suggests obstructive mechanism, but the result is uncertain. Dementia is not conclusive in our series. In young child the efficacy is related to the aetiology and not to the age. And in narrow ventricles and during infection, our personal opinion is that ETV could succeed eventually.

Conclusions: We could conclude that all unusual indications for ETV had not the same results with the orthodox cases. But in selected cases, with experience and attention to the technique and indication, it could be helpful

Endoscopic management of hydrocephalus in special situations

C. Brusius, R. Borba, S. Cavalheiro (Porto Alegre, Brazil)

The authors discuss the indications for neuroendoscopic surgery in 24 cases of specific forms of hydrocephalus, considering the

management of intracranial pressure and CSF dynamics. In conclusion, neuroendoscopy and neuronavigation, in selected cases, improved the performance of the treatment. Future studies and a better understanding of hydrocephalus and the CSF dynamics will help us to create protocols to treat such specific forms of hydrocephalus.

Shunt removal and endoscopic treatment of obstructive hydrocephalus: a “road map” for safe management

G.M. Ravegnani, A. Cama (Genova, Italy)

Nowadays, obstructive hydrocephalus is firstly approached by endoscopy, while shunt is placed only if strictly necessary. Aim of our study is to identify, among the 534 patients with shunt treated in the last 10 years, those for whom it is indispensable. So we propose an algorithm of procedures to safely remove device to patients who have not developed shunt dependence. We divide patients who are developing a clinical and/or radiological feature of shunt dysfunction from asymptomatic patients who need a programmed shunt revision. In the first group if the patients are critical, we don't prove any removal. Otherwise, after a CT scan performed by a neuro-navigation protocol and, in case of cardiac shunt, an heart echotomography, we perform, in the same time, the endoscopic third ventriculostomy (ETV), eventually by the navigation guide if the ventricle size is small, we restore the shunt function and finally take the distal catheter (peritoneal or cardiac) outside in external drainage. For the next 7–10 days we can stop from draining the shunt and contemporaneously both verify the ETV permeability and monitor the intracranial pressure (ICP). If at the end of this period the patient is clinically and instrumentally normal, we close the distal catheter, keeping it under the skin, for six months; finally we remove the shunt after a neuroradiologic control. For the patients whom a programmed shunt revision is desirable we take outside the distal catheter: if no liquid comes through the shunt we keep it in an external drainage for 3–4 days, ICP monitoring. If still no liquid is drained and the patient is clinically and neuroradiologically normal, we close the distal catheter keeping it under the skin for six months, then we remove the shunt. If, otherwise liquid still flow out of the shunt, at once or subsequently, we proceed with a protocol as already explained for the first group of patients. With these procedures we can determine if patients are shunt dependent and we can safely remove the drainage from the patients with obstructive hydrocephalus among whom the device is not necessary.

Endoscopic third ventriculostomy versus cerebrospinal fluid shunt in the treatment of hydrocephalus in children: a propensity score – Adjusted analysis

A.V. Kulkarni, J.M. Drake, J.R.W. Kestle, C.L. Mallucci, S. Sgouros, S. Constantini and the Canadian Pediatric Neurosurgery Study Group (Toronto, Canada; Salt Lake City, USA; Liverpool, United Kingdom; Birmingham, United Kingdom and Athens, Greece; Tel Aviv, Israel)

Introduction: It is still unresolved whether ETV failure rates are truly better than those of CSF shunt. Comparing failure rates has been virtually impossible because ETV has preferentially been offered to patients with more favourable prognostic features. This creates the problem of ‘confounding-by-indication’, which means that ETV might appear to have more favourable outcome, but we can't know whether that is because it is a better procedure than

shunt or simply because better patients were chosen to receive ETV. Currently, there is no randomized data to resolve this. Therefore, we used the well-described statistical technique of ‘propensity score analysis’ to overcome this ‘confounding-by-indication’.

Methods: A multicentre, international cohort of children (<19 years old) with newly diagnosed hydrocephalus treated with either ETV (N=489) or shunt (N=647) were analyzed. Propensity scores were calculated from a logistic regression model using patient age and hydrocephalus aetiology as the independent variables. Cox regression survival analysis was then performed to compare time-to-treatment failure in an unadjusted model and propensity score-adjusted models. These adjusted models corrected for the differences in the ages and aetiologies of the ETV and shunt group.

Results: In the unadjusted model (which did not correct for favourable patient prognostic factors) the ETV failure rate appeared to be lower than shunt right from the immediate postoperative phase and became even more favourable with longer duration from surgery. Once patient prognostic features were corrected for, however, shunt actually performed better in the early postoperative phase but, over time, ETV progressively fared better.

Conclusions: While ETV demonstrates a lower long-term failure rate than shunt, adjustment for patient prognostic factors reveals a higher early failure rate compared to shunt. Ignoring the impact of patient prognostic features would lead to an overly favourable assessment of ETV over shunt. In appropriately selected patients, however, ETV can still have better long-term results.

Effectiveness of endoscopic third ventriculostomy in children in relation to age and aetiology of hydrocephalus

M. Mandera, W. Szopa (Katowice, Poland)

Introduction: The object of the study was to assess the effectiveness and safety of endoscopic third ventriculostomy (ETV) in children treated for hydrocephalus in relation to age and etiology of hydrocephalus.

Material: Between January 2001 and December 2008, 117 children were treated at our institution by ETV for hydrocephalus. The patients’ age ranged from 2 days to 18 years. Sixty children were younger than two years at the time of surgery and 50 of them were infants. The group of patients older than 2 years consists of 57 cases. The mean follow-up period for all patients was 3.3 years (ranged from 2 months to 7.6 years). The cause of hydrocephalus was aqueduct stenosis in 39 (33%) patients, tumour in 29 (25%) patients, Dandy-Walker malformation in 10 (9%), newborn intraventricular hemorrhage, and intraventricular cysts in 7 (6%) patients each, myelomeningocele in 5 (4%), meningitis in 4 (3%) and other in 16 (14%) patients. Four patients were previously shunted and in two cases ETV was performed twice. ETV failure was defined as subsequent need for shunt implantation. Both univariate and multivariate statistical analyses were performed to assess the efficacy of the ETV in relation to age of the patients and etiology of hydrocephalus.

Results: The overall success rate for ETV was 72% in the short postoperative period and 65% in long-time follow-up. Complications occurred in 9 cases (7.7%). The success rate was significantly worse in the group of infants comparing to older children. Success rate of ETV was significantly higher in patients

with aqueductal stenosis or tumors as compared to other etiologies. However multivariate analysis showed that infancy was the only independent negative factor.

Conclusion: ETV is a very effective treatment of children older than 1 year, especially if hydrocephalus is caused by aqueductal stenosis or tumour.

Third ventriculostomy in infants under 1 year of life. Report of 25 cases

M. Rial, A. Cordoba (Montevideo, Uruguay)

Introduction: Endoscopic Third Ventriculostomy is controversial in children with hydrocephalus under the first 1 year of life especially in preterms and spina bifida. Different protocols are running at this time; nevertheless we must wait results of great series until 2012.

Material, methods and results: 25 children in the period 2002–2007, 15 males and 10 females, with a mean age of 5.2 months, 8 preterm with intraventricular haemorrhage and 17 term infants with malformative hydrocephalus were operated. The success rate in the global series was 58.8%. (mean follow up 12.8 months)

Discussion: Even with significant failure rate in these children, third ventriculostomy is useful in cases where is necessary, waiting to improve clinical and general condition before putting a definitive shunt.

Endoscopic third ventriculostomy in patients younger than 2 years

A. Sufianov, Iu. Iakimov, G. Sufianova (Irkutsk, Russia)

Introduction: In last decade the reported success rate of endoscopic third ventriculostomy (ETV) in the literature in different age groups before 3, 6 months, 1, 2 years range from 0% to 83,3% and that is higher compared with that of older children.

Patients and Methods: Between 1998 and 2008 we treated 107 patients with hydrocephalus by ETV. From them, 42 procedures were performed in 41 patients below 2 years. Middle age at the time of operative treatment was $0,88 \pm 0,09$ years (0,16–2,00 years). Before 1 year there were 26 infants (63,4%). Success of endoscopic procedure was estimated by results of the neurologic examination and postoperative imaging during the follow up period. ETV was considered successful when no shunt operation was needed in the patient and no progressive hydrocephalus was present. The mean follow-up period was $45,0 \pm 5,7$ months (1–127 months).

Results: All patients were operated technically successfully without complication during operation. We performed primary ETV in 32 cases and secondary ETV (after shunt surgery of hydrocephalus before ETV) in 10 cases. The ETV procedure was clinically and radiologically successful in thirty cases (71,4%). Dependence between efficiency of operation and the thickness of floor of third ventricle was revealed ($p < 0,05$). There is statistically significant correlation between success of ETV and prolapse of the third ventricle ($p < 0,001$). In our group of patients there was dependence between efficiency of operation and the age in which the first sign of hydrocephalus was presented (the most effective operations at occurrence of a hydrocephalus after first month, $p = 0,02$).

Conclusion: Endoscopic surgery offers effective and safe technique in the surgical treatment of hydrocephalus at children younger than 2 years. According to our results the use of

endoscopic third ventriculostomy at children younger than 2 years allows to achieve success in 71,4% and at infants in 75,0%. Success of ETV in children younger than 2 years depends not on the age of the patient and on the cause of the hydrocephalus but on the thickness of floor of the third ventricle and age of first manifestation of the hydrocephalus.

Evaluation of the age limit of 1 year to treat the hydrocephalus by endoscopy

H. Kadri, A.A. Mawla (Damascus, Syria)

22 patients who were 1 year old and suffering from non communicating hydrocephalus due to multiple malformative membranes or aqueduct stenosis associated with MM, were operated on by endoscopy. 12 of them (group 1) were suffering from MM and initially were treated by VPS, and were admitted to our unit for valve malfunctioning. 10 patients (group 2) were suffering from malformative non communicating hydrocephalus. 40% of the patients in both groups responded to the endoscopic procedure. Compared to a previous study concerning patients who are younger than 1 year and underwent an endoscopy procedure done in our unit (success rate of 35%), it seems that there is no significant improvement of the result of both studies.

Radiological features of hydrocephalus due to isolated aqueduct stenosis in children in the first 2 years of life. Qualitative analysis of neuroradiological material of the International Infant Hydrocephalus Study

K. Papademetriou, S. Sgouros, A. Kulkarni, S. Constantini (Athens, Toronto, Tel Aviv and the Investigators of the International Infant Hydrocephalus Study)

Introduction: The IIHS is a randomized controlled study aiming to analyze the impact of shunt or ETV in the neuropsychological development of children who present with hydrocephalus due to isolated aqueduct stenosis in the first 2 years of life. The trial offers the opportunity to study the radiological features of a very large series of children with aqueduct stenosis, in order to identify neuroradiological features and morphological patterns of the ventricular system.

Material and Methods: Until February 2009 118 children have entered the study. Qualitative analysis has been performed in 70 children with complete set of representative preoperative MR scans. Particular attention was paid to 22 distinct radiological features, which are commonly seen in aqueduct stenosis.

Results: Mean Evans ratio was 0.5, the same for both sexes. The following features were present: periventricular oedema was mild in 39 (56%) moderate in 22 (31%) and severe in 9 (13%) of the patients, rounded frontal or occipital horns in all but one, presence of thickened interthalamic adhesion in 15 (21%), stretched corpus callosum in 64 (91%), detachment of fornix in 44 (63%), aqueduct stenosis in all, ventricular diverticulum in 10 (14%), bulging of tuber cinereum in 25 (36%), reduced distance between clivus and basilar artery in 9 (13%), dilatation of supraoptic recess in 51 (73%), dilatation of suprapineal recess in 39 (56%), enlarged cisterna magna in 49 (70%), hypoplastic vermis in 9 (13%), dilated 4th ventricle in 4 (57%), effaced supratentorial subarachnoid spaces in 63 (90%), loss of grey-white matter differentiation in 12 (17%), evidence of intraventricular haemorrhage in 17

(24%), colpocephaly in 16 (23%), assymetrical lateral ventricles in 5 (7%). No patient had presence of flow void within the aqueduct in mid-sagittal view, periventricular white matter demyelination, Chiari I malformation or choroid plexus hypertrophy.

Conclusions: This study represents the largest collection of patients in the first 2 years of life with pure isolated aqueduct stenosis in the literature. Two distinct patterns of ventricular system configuration have been identified: children with moderate ventricular enlargement and good “cortical mantle” and children with large ventricles, thin “cortical mantle” and ventricular configuration similar to colpocephaly (disproportionately large occipital horns). The correlation of radiological features to success of surgical treatment and neuropsychological outcome will be evaluated after completion of analysis of the trial data.

Endoscopic treatment for posthemorrhagic hydrocephalus in premature newborns

R. Lipina, H. Podesvova, L. Novackova (Ostrava, Czech Republic)

Introduction: Up to date the pathophysiology of posthemorrhagic hydrocephalus (PHH) in premature newborns is explained as a consequence of cytokine TGF β 1 release into cerebrospinal fluid (CSF) during initial bleeding, followed by induction of “inflammatory proteins” in subarachnoidal spaces. Method of choice in treatment of PHH is ventriculo-peritoneal drainage. The role of endoscopic third ventriculostomy (ETV) in these patients is unclear, through obstruction is proved in some patients with PHH. The aim of our study was to monitor the success rate of ETV in the group of premature newborns with obstructive PHH and to ascertain the relation between TGF β 1 levels and ETV success rate.

Materials and methods: We followed 38 premature newborns with PHH since January 2004 to November 2007. 34 patients were treated by Ommaya reservoir implantation and repeated taps. In 29 patients TGF β 1 level was examined. In case of persisting hydrocephalus (30 patients) MRI of brain was performed. In 21 patients with proved obstruction on MRI ETV was indicated. We evaluated ETV success rate and relation to TGF β 1 CSF levels. *Results:* In 70% patients in our series the hydrocephalus was obstructive. Success rate of ETV in this group of patients was 52%. There was statistically relevant probability in diagnosis of hyporesorptive hydrocephalus based on TGF β 1 level in CSF. Level exceeding 3296 pg/ml means 81,3% probability of presence of hyporesorption. Success rate of ETV in patients with MR proved obstruction and TGF β 1 level lower than 3296 pg/ml was 100% in our series.

Conclusion: The results of our work proved that there is a group of premature newborns with obstructive PHH and the success rate of ETV in these patients is comparable with patients of other types of obstructive hydrocephalus in the same age group. TGF β 1 level in CSF indicates participation of hyporesorption in hydrocephalus development even in patients with proven obstruction on MRI and is associated with the success rate of ETV.

Removal of ventricular catheters in secondary neuroinfection and infection of the derivative system

J.F. Ramon (Bogota, Colombia)

Objective: The patients with hydrocephalus managed by systems of ventriculo-peritoneal or ventriculo-atrial derivation that present with

infections of the derivative system with meningitis and or ventriculitis require the removal of such system as part of his treatment. In many cases the adherences generated around the catheter in the ventricular system interfere with conventional removal of these systems causing mostly serious intraventricular haemorrhage and other complications. In these cases neuroendoscopy is an alternative way to secure removal of such catheters controlling the risk of secondary injuries.

Methods: 10 patients are described that were operated between December 2006 and January 2009 with ages between 1 and 18 years old that presented with secondary neuroinfection to the infection of the derivative system, the removal of which was done with neuroendoscopy aside from ventriculostomy and antibiotic treatment. **Results:** 10 patients were operated with ages between 1 and 18 years old (9 less than 10 years old with an average age of 3,6). From the population analysed 80% had between 2 and 5 previous surgeries and at the time of neuroendoscopy 30% had 1 catheter, 60% had 2 catheters and 10% had 3 catheters. The totality of the catheters were removed without complications intraoperative or postoperative.

Conclusion: Neuroendoscopy can be a secure alternative for the management of patients with hydrocephalus and neuroinfection that permits the removal of the catheters without complications.

Management of hydrocephalus in posterior fossa tumours. When is ETV indicated? Is it safe? Is it easy?

C.E. Gagliardi, L.M. Cuello, P.Z. Maggiora (La Plata, Argentina)

Introduction: Treatment of hydrocephalus in posterior fossa tumours is still a matter of controversy, and different centres have their own protocols. Patients with increased ICP associated with posterior fossa tumours may be considered to have two different diseases: hydrocephalus and the tumour itself. The management of such hydrocephalus may be done by preoperative drainage or ETV. Another possibility is to perform the extirpation of the tumour, proceeding with the treatment of hydrocephalus only in patients with persistent ventricular dilatation.

Material and methods: We analyzed our experience and complications in the management of hydrocephalus in patients with posterior fossa tumours, and compared it with the publications of different authors.

Results: One of the more important facts is that all the consulted information concludes that nearly 80% of the patients operated for extirpation of posterior fossa tumours are shunt free, and that many of the patients who required a shunt had malresorptive hydrocephalus related with haemorrhage or other circumstances that affect the normal CSF reabsorption. In addition, ETV in these patients has many technical difficulties: for instance, the basilar artery and its branches are usually pressed against the clivus and the ventricular floor, increasing the risk of vascular damage. We operated on a patient in whom the basilar artery was herniated through the ventriculostomy due to posterior fossa hypertension.

Conclusion: We conclude that in patients with resectable tumours, direct tumour extirpation is the best alternative, followed, if necessary, by shunt placement or ETV when indicated. When ICP is very high and complications related with hydrocephalus are predicted, ventricular drainage is a safer technique than ETV before tumour resection.

Endoscopic third ventriculostomy in the treatment of hydrocephalus in posterior fossa tumours in children: our experience

C. Ruggiero, P. Spennato, F. Aliberti, V. Trischitta, G. Cinalli (Napoli, Italy)

Object: the purpose of the present study is to assess the effectiveness of endoscopic third ventriculostomy (ETV) in children with hydrocephalus related to posterior fossa tumours.

Methods: between January 2000 to December 2008, 156 children with posterior fossa tumours were treated at Santobono Children Hospital in Naples, Italy. 53 patients had severe hydrocephalus. In order to relieve intracranial hypertension before tumour removal 46 were treated with ETV, and 7 with ventriculo-peritoneal (VP) shunts. 63 patients with mild hydrocephalus were treated with diuretics, corticosteroid agents, and early posterior fossa surgery, and 40 patients who did not have hydrocephalus were treated by elective posterior fossa surgery. Another 12 ETV were performed in the management of postoperative hydrocephalus.

Results: preoperative ETV procedures were technically successful. One was complicated by intraventricular bleeding. The successful 52 preoperative ETV resolved intracranial hypertension before posterior fossa surgery in all cases. 13 of these 52 patients developed postoperative hydrocephalus and were treated by VP shunt insertion after posterior fossa surgery. Out of the 12 ETV performed after posterior fossa surgery only 7 were successful.

Conclusions: Endoscopic third ventriculostomy should be considered as an alternative procedure to ventriculo-peritoneal shunting and external ventricular drainage for the emergency control of severe hydrocephalus caused by posterior fossa tumours, since it can quickly eliminate symptoms, and hence, can delay surgery scheduling if required, even though ETV does not prevent postoperative hydrocephalus due to cerebellar swelling. In addition, it eliminates the risks of cerebro-spinal fluid (CSF) infection related to external drainage and minimizes the risk of overdrainage because it provides more physiological CSF drainage than the other procedures. Since postoperative hydrocephalus is very often physically obstructive, ETV should always be considered as a possible treatment procedure.

The influence of ETV on the width of the third ventricle in different causes for obstructive hydrocephalus

Y. Mondorf, M.R. Gaab, J. Oertel (Hannover and Mainz, Germany)

Objective: A malformation of the posterior fossa and a giant aneurysm of the basilar artery could lead to a chronic obstructive hydrocephalus on the contrary an intracerebral haemorrhage could lead to an acute obstructive hydrocephalus. Between 2003 and 2008, 33 endoscopic third ventriculostomies were performed at the Nordstadt Krankenhaus Hannover (since March 2003) in these three different pathologies.

Methods: Between 2003 und 2008, 14 endoscopic third ventriculostomies (ETV) in malformation of the posterior fossa, 17 ETVs in patients suffering from an intracerebral haemorrhage and two ETVs in patients suffering from a giant aneurysm from the basilar artery were performed. All patients showed a dilation of the third ventricle preoperatively. In all cases the width of the third ventricle was measured preoperatively and compared to the width postoperatively.

Results: The course of this parameter was different in all three groups. All patients received an MRI or a CT scan pre- and postoperatively. The width of the third ventricle in the group suffering from posterior fossa malformation was preoperatively highly pathologic (>15 mm) in 11 (78.6%), moderately pathologic (11–14 mm) in 2 (14.3%), mildly pathologic (8–10 mm) in 1 (7.1%), and normal (<7 mm) in 0. The width of the third ventricle decreased postoperatively in 9 (64.3%), remained unchanged in 4 (28.6%) and further deteriorated in 1 (7.1%), nevertheless the clinical improvement was significant. In the patients with an intracerebral haemorrhage the width was preoperatively pathologic in 15 cases (88.2%). Postoperatively it improved in 14 (82.3%) cases, however 8 patients died. In both patients with the giant aneurysm of the basilar artery the width reduced from 2.1 to 1.9 mm and from 1.4 to 1.0 mm.

Conclusions: The influence of ETV on the width of the third ventricle depends on the type of hydrocephalus whether it is chronic or acute. The course of the width of the third ventricle does not show any coherence to the clinical development necessarily.

Is endoscopic aqueductoplasty really an alternative to endoscopic third ventriculostomy in the treatment of hydrocephalus caused by aqueductal stenosis?

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Objective: Endoscopic aqueductoplasty (AP) and endoscopic third ventriculostomy (ETV) are considered to be options in the treatment of obstructive hydrocephalus caused by aqueductal stenosis. We compared the success rates of both techniques.

Methods: 70 patients harbouring hydrocephalus caused by aqueductal stenosis were evaluated. 39 patients underwent ETV, 20 patients AP, and 14 patients both ETV and AP simultaneously. There was no endoscopy-related mortality. One AP had to be abandoned. The mean follow-up period was 40 months (ranging from 1 to 97 months). In eight of the 20 patients (40%) who underwent an AP, reclosure of the restored aqueduct required an endoscopic revision. However, in only 4 of the 36 patients (11%) who underwent ETV, a reclosure of the stoma required another intervention. In the 14 patients in whom ETV and AP were performed, only 1 patient required surgical intervention. Therefore, the long-term success rate was 80% in the ETV group, 60% in the AP group, and 85% in the ETV / AP group. In 25 patients (76%), the hydrocephalus-related symptoms resolved or improved. The condition was unchanged in eight patients. Four patients needed to be shunted. The ventricles decreased in size in 22 patients (67%), were larger in two, and unchanged in the remaining nine patients.

Conclusion: Endoscopic aqueductoplasty has a high reclosure rate in the long-term and should only be performed when ETV seems to be impossible or too risky. When AP is performed, a stent should be inserted to prevent reclosure of the restored aqueduct.

Report of 360 neuroendoscopic procedures: results, analysis and discussion

A. Cordoba (Montevideo Uruguay)

Introduction: We started to perform neuroendoscopy in 2002. The senior author introduced this technique in our country, Uruguay.

Material and methods: Since 2002 360 neuroendoscopic procedures have been performed: 205 third ventriculostomies, 30 cranial

arachnoid cysts, 7 spinal arachnoid cysts, 5 colloid cysts, 4 pituitary surgery, 35 aneurysm assisted clipping and bypasses, 20 cerebral tumours 30 stem cells implants, 10 spinaloscopies and 14 syringomyelia with flexible techniques.

Discussion: Advantages and disadvantages of this technique are discussed, comparative with the results of microsurgery alone. We added progressively clinical practice joined with teaching activities in the Latin American Group of Neuroendoscopy in all of Latin America.

The course of the Sella-Media-Index according to Schiersmann after ETV in different causes for obstructive hydrocephalus

Y. Mondorf, M.R. Gaab, J. Oertel (Hannover and Mainz, Germany)

Objective: Malformations of the posterior fossa and giant aneurysm of the basilar artery could lead to a chronic obstructive hydrocephalus, while intracerebral haemorrhages lead to acute hydrocephalus. Between 2003 und 2008, 33 endoscopic third ventriculostomies were performed at the Nordstadt Krankenhaus Hannover in the pathologies mentioned above.

Methods: Fourteen endoscopic third ventriculostomies (ETVs) in malformation of the posterior fossa, 17 ETVs in patients suffering from an intracerebral haemorrhage and two ETVs in patients suffering from a giant aneurysm from the basilar artery were performed. Patients' age comprised 1 month up to 83 years. All patients suffered from a ventricular dilatation preoperatively and a clinical presentation of hydrocephalus. The sella-media-index was analysed pre- and postoperatively.

Results: All patients received an MRI or CT-scan pre- and postoperatively. Preoperatively, all patients with a malformation of the posterior fossa suffered from significant enlargement of the ventricles. The sella media index according to Schiersmann was preoperatively highly pathologic (<2.9) in 12 (85.7%), moderately pathologic (3.5–3.0) in 2 (14.3%), mildly pathologic (4.0–3.6) in 0, and normal (>4.1) in 0. Postoperatively, the sella-media-index improved in 8 (57.1%), remained unchanged in 1 (7.1%), and further decreased in 5 (35.7%). In the patients with an intracerebral haemorrhage the sella-media-index was preoperatively pathologic in 16 (94%). Postoperatively it improved in 12 (70.6%) and was normal in 4 cases (23.5%). In both patients with the giant aneurysm of the basilar artery the sella-media-index raised from 2.84 to 3.0 and from 2.73 to 3.09.

Conclusions: The course of the sella-media-index is dependent of the type of the obstructive hydrocephalus. Although especially in the group suffering from a malformation of the posterior fossa after ETV no normal sella-media-index could be found the clinical improvement was significant. In the patients with intracerebral haemorrhage and a high improvement of the sella-media-index after ETV 8 patients died. Both Patients suffering from giant aneurysm had an improvement of the sella-media-index and the clinical status.

Endoscopic third ventriculostomy in extraventricular intracisternal obstructive hydrocephalus

Y. Ersahin, T. Turhan (Izmir, Turkey)

Introduction: Endoscopic third ventriculostomy (ETV) is considered the first choice of treatment in the management of non-

communicating hydrocephalus. However, some authors reported successful results with ETV in communicating hydrocephalus and normal pressure hydrocephalus. Kehler et al coined the term “extraventricular intracisternal obstructive hydrocephalus” in the patients with the following MR finding: a downward bulging floor of the third ventricle, a patent aqueduct and dilated ventricles and a large cisterna magna as well as normal or even small further basal cisterns. ETV was successful in those 5 patients. We report on the patients with extraventricular intracisternal obstructive hydrocephalus in which ETV was performed.

Material and Methods: Fifteen patients in which MR findings were consistent with extraventricular intracisternal obstructive hydrocephalus underwent ETV. There were nine females and 6 males, ranging in age from 9 months to 40 years (mean 16.6 years). Follow-up of the patients ranges from 6 to 50 months (mean 16.5 months).

Results: Two of the patients had been shunted and ETV was performed at the time of shunt malfunction. Only 3 (20%) of the 15 patients needed a ventriculo-peritoneal shunt. Three patients had intraventricular haemorrhage, posttraumatic subdural haematoma and subarachnoid haemorrhage and subdural haematoma in their history.

In conclusion, the entity of “extraventricular intracisternal obstructive hydrocephalus” exists. bleeding or inflammation might have led to obstructions of the small cisternal openings. ETV seems to be effective as much as in non-communicating hydrocephalus.

Thirty years of experience with endoscopic third ventriculostomy

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Objective: To present the 30 years of experience, and the largest series yet reported, of endoscopic third ventriculostomy (ETV) at a single institution including the short-term operative success and the long-term reliability of the procedure in the treatment of hydrocephalus. We examine the impact of causative diagnosis, age, and previous neurosurgical history on operative success and long-term outcome.

Methods: We evaluated the outcomes of the 301 consecutive patients who underwent ETV at a single institution over the last 30 years. The study included patients with hydrocephalus resulting from a range of conditions including aqueduct stenosis, tumours, myelomeningocele, infection, arachnoid cysts and haemorrhage.

Results: The patients ranged in age from 0 to 80 years. ETV was successfully performed in over 90% of patients. The proportion of patients with a presumably functioning ETV at 5 years was greater than 75% for those over 2 years of age. Major and permanent complications occurred in 1% of cases. Previous shunt surgery or shunt infection, surgeon, or pathogenesis of the hydrocephalus did not have a clinically significant effect on the success of ETV in the short or long term.

Conclusion: Age was the only statistically significant factor affecting the long-term success of ETV. ETV is proving itself as a reliable long-term surgical option in the treatment of hydrocephalus regardless of pathogenesis.

Neuroendoscopic approach to multilocular hydrocephalus

A.-E. Shehab-Eldien, M.S. Abd-Elmoneim (Cairo, Egypt)

Background: Neuroendoscopic premammillary third ventriculostomy (NTV) is proved to be an effective minimally invasive procedure for

CSF diversion. Multilocular hydrocephalus constitutes a challenging group of patients that can't be simply treated through a single shunt insertion or (NTV).

Objectives: To evaluate the role and effectiveness of the use of neuroendoscopy for management of multilocular hydrocephalus.

Patients and Methods: Out of 1032 patients presented with symptoms & signs of increased intracranial pressure due to hydrocephalus (mean age: 23 months), 492 were selected for neuroendoscopic surgery. Multilocular hydrocephalus existed in 18 patients. Adequate clinical and radiological evaluation (CT & MRI) was achieved. The appropriate endoscopic approach was suited for each according to the definitive pathology (loculi/cyst fenestration, septum-pellucidotomy or ventricular catheter lysis). Concomitant NTV was performed in 6 patients. An existing obstructed ventriculo-peritoneal shunt was revised in 8 patients (6 endoscopically and open in 2) and a single new device was implanted in 4. Clinical and radiological follow-up ranged from 17 months to 11 years.

Results: Clinical improvement of 14 out of 18 patients. Radiologically, ventricular communication was obtained in 16 in repeated serial radiological studies and repeated endoscopic fenestration was necessary in the remaining 2. One patient developed shunt infection that necessitated removal and external drainage, followed by a new shunt insertion. Another 2 developed shunt obstruction and replacement. Asymptomatic fornix contusions occurred in 3; transient CSF leakage in 1 patients.

Conclusion: Neuroendoscopy is a simple, safe, effective and minimally invasive treatment option for CSF diversion. It obviates the need for a new shunt insertion in a good sector of the patients presented with multilocular hydrocephalus. Meanwhile, the complex problems were simplified for the remaining, where multiple shunt insertion was avoided.

Third ventriculostomy in malformation of the posterior fossa

Y. Mondorf, M.R. Gaab, J. Oertel (Hannover and Mainz, Germany)

Objective: A malformation of the posterior fossa often leads to obstructive hydrocephalus. The reason could mostly be found in obstruction of the Foramina Luschka and Magendi or a dysgenesis of the foramina. Third ventriculostomy (ETV) might represent an ideal therapeutic option aside from ventriculoperitoneal shunting. Due to the low frequency of this kind of diseases outcoming reports are rare.

Methods: Between 1995 und 2008, 22 endoscopic third ventriculostomies in malformation of the posterior fossa were performed at the Ernst Moritz Arndt Universitaet Greifswald (until March 2003) and at the Nordstadt Krankenhaus Hannover (since March 2003). Patients' age comprised 1 month up to 79 years. All patients suffered from a ventricular dilatation preoperatively and a clinical presentation of hydrocephalus. All patients were examined immediately after operation and 14 patients underwent follow-up-examinations.

Results: In 17 patients a shunt implantation could be avoided. 13 patients experienced permanent relieve of symptoms. Despite endoscopic surgery, ventriculoperitoneal shunting was required in 5 patients. There were no relation between the patients' age and the result of ETV. Complications during the surgery were rare and consisted essentially of intraventricular bleedings, lesions of the fornix or CSF - fistulas. Lesions of the basilar artery did not occur.

Conclusions: Endoscopic ventriculostomy is a successful treatment option for obstructive hydrocephalus caused by malformation of the posterior fossa. However it is not always possible to abandon a shunt implantation in those syndromes. Endoscopic third ventriculostomy shows less complications than shunt implantation for a symptomatic treatment of obstructive hydrocephalus.

Efficacy of endoscopic third ventriculostomy in children with craniosynostosis

F. Di Rocco, E. Juca, R. Ven, E. Arnaud, D. Renier (Paris, France)

Object: Aim of this study is to assess the efficacy of endoscopic third ventriculostomy in the treatment of hydrocephalus in children with craniosynostosis.

Patients and Methods: Charts from 2194 children treated at the Craniofacial Unit of Necker Enfants Malades between 1995 and 2008 were reviewed. Among them 293 were affected by a syndromic faciocraniosynostosis. The management of hydrocephalus by endoscopic third ventriculostomy was searched as well as eventual complications.

Results: Among 46 patients with hydrocephalus, an endoscopic third ventriculostomy was performed in 10 children (7 boys, 3 girls). They were all affected by a faciocraniosynostosis (Crouzon syndrome in 5, Pfeiffer in 3 and unclassifiable in 2). A Chiari malformation was found in 4. In 5 children the hydrocephalus was controlled by endoscopic third ventriculostomy. One child died due to associated malformations. In the remaining 4 cases a ventriculoperitoneal shunt was further needed (delay between the two surgeries ranging from 1 week to 6 months). The follow-up ranges from 3 months–13 years.

Conclusions: An endoscopic third ventriculostomy may allow to control hydrocephalus in selected cases. However due to appreciable failure rate a close clinical and radiological monitoring of these children is mandatory.

Graphic results of endoscopic third ventriculostomy in hydrocephalic patients

J. Chrastina, Z. Novak, I. Riha, V. Feitova, K. Ghallab (Brno, Czech Republic)

Introduction: The aim of the study is to evaluate the effect of functioning ETV for hydrocephalus on the geometry of the third ventricle. Surgical planning computer software enables linear, planimetric and volumetric measurements with subsequent analysis possible. Literature data suggest that the decrease of brain ventricles size after surgery is not as marked as after shunt surgery.

Material and Methods: Parameters describing geometry of third ventricle and its floor were defined: - CA-CP (intercommissural distance) - key parameter for stereotactic neurosurgery - H (height) - the height of the third ventricle - IMD (intermamillary distance) - the distance between anterior margins of mamillary bodies - BA-MB - the distance between basilar bifurcation and mammillary bodies - DS-BA - the distance between dorsum sellae and basilar bifurcation The parameters were measured on standard planning MRI studies (T1WI 3D, slice thickness 1.2 mm) with the help of stereotactic planning software Praezis Plus. 3–6 months after surgery MRI studies were performed to evaluate the flow through the neuroendoscopic opening (flow void) together with clinical investigation. Only patients with adequate flow - void were included in the study.

Results: The study group consists of 40 patients with obstructive hydrocephalus treated by endoscopic third ventriculostomy. MRI after surgery provided clear evidence of endoscopic third ventriculostomy patency. Statistical evaluation was performed by means of Wilcoxon Matched Pairs test and Sign test. There was significant statistical difference for CA - CP, H and IMD distance before and after surgery with distances shortening after surgery ($p < 0,01$). No significant difference was revealed for the parameters DS-BA and BA-MB describing third ventricular floor before and after surgery.

Conclusions: The study presents clear evidence of significant reduction of third ventricle linear parameters. The result of the changes of third ventricular floor morphometry are not followed by significant changes of third ventricular floor parameters, though the changes may be expected due to the nature of the surgical procedure.

Complication avoidance during endoscopic third ventriculostomy

L. Bognar, B. Markia, L. Novak (Debrecen, Hungary)

Introduction: In the past years the endoscopic third ventriculostomy became a routine treatment for different forms of obstructive hydrocephalus. The operation can restore elegantly the normal CSF circulation but in certain cases the complications cast a shadow on results.

Material: 327 consecutive cases of endoscopic ventriculostomies were analysed with special attention to complications and to their handling and treatment. Failure of the patent ventriculostomy was not considered as a surgical complication.

Results: Complications were noted in 19 cases (5.8%). They included intraoperative bleeding (9), chronic subdural haematomas (2), wound healing problem (1), subgaleal collections (6) and CSF leak (1). No fatal event or permanent morbidity were observed.

Conclusion: Preoperative analysis of MRI pictures helps to prevent unexpected events during operations. It means that not only the aqueduct should be inspected, but the anatomy of the cranial base, the posterior fossa CSF spaces and the course of the basilar artery need to be evaluated too. The low rate of complications also affirms the basic role of the endoscopic third ventriculostomy in the treatment of noncommunicating hydrocephalus.

Endoscopic third ventriculostomy: analysis of factors associated with failure of the procedure

C.E. Gagliardi, L.M. Cuello, P.Z. Maggiora (La Plata, Argentina)

Introduction: Endoscopic third ventriculostomy (ETV) has become the procedure of choice for the treatment of obstructive hydrocephalus. Nevertheless, success rates vary significantly among different reports. Ventriculostomy failure has been defined as the necessity for a subsequent surgical procedure due to persistence or recurrence of symptoms of intracranial hypertension.

Material and methods: Fifty-five publications concerning failure rates for ETV and physiopathological issues were reviewed. Risk factors were listed and analyzed.

Results: Age < 6 months, specially < 1 month, and prematurity were recognized as predictors of poor results; this was attributed to the immaturity of the LCR absorption mechanisms and insufficient development of arachnoid granulations. Patients with Chiari malformation were good candidates for ETV for treatment of hydrocephalus, but the resolution of syringomyelia seemed to require permeability of the subarachnoid space (SAS) dorsal and

ventral to the brainstem. Myelomeningocele was associated with high failure rates when ETV was performed in newborns because of incomplete development of the SAS. Intracranial haemorrhage and infection were strong predictors of poor results in the few months following the event, but not later. Secondary neoplastic compromise of the CNS was associated with failure of the procedure, presumably because of reactive or infiltrative changes in the SAS. Technical issues, such as stoma size and presence of secondary membranes are discussed.

Conclusions: The success of ETV for the resolution of hydrocephalus resides in the correct diagnosis of pure obstructive hydrocephalus, and the presence of a well developed SAS. Advances in the knowledge of CSF production, circulation and absorption will lead to better selection of surgical candidates.

ETV-Registry in Germany: concept and current status

M.J. Fritsch, H.W.S. Schroeder and The ETV-Registry Group Germany (Greifswald, Germany)

Introduction: Endoscopic third ventriculostomy (ETV) has become the standard treatment for obstructive hydrocephalus. Nevertheless, prospective multicenter data acquisition regarding indication, technique and outcome is missing.

Material and Method: The Section of Neuroendoscopy is establishing a web based ETV-Registry (<http://etv-register.drhey.dyndns.org>) with the aim to collect data from (all) german neurosurgical centres. Patient data include age, sex, diagnosis, indication, technical details of surgery and equipment, clinical and radiological follow-up. Publication of data is planned once per year.

Results: The test-website is online for participating centres.

Conclusion: Prospective data, documenting the vast majority of ETV-cases will allow answering so far unsolved questions concerning e.g. the role of age and etiology, technical aspects and the long term success rate of ETV.

Is the distance between mammillary bodies predictive of successful third ventriculostomy?

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The aim of this study was to correlate intraoperative endoscopic third ventriculostomy (ETV) findings in hydrocephalic patients with the MR imaging appearance of the mammillary bodies (MBs).

Material and Methods: The authors reviewed brain MR images and intraoperative ETV records in 23 patients with hydrocephalus as well as MR imaging data from 120 randomized control volunteers of various ages to define the normal intermammillary distance (IMD).

Results: In control volunteers, no measurable IMD (“kissing” configuration) was observed in 91 (85%) of 107 cases, and there was mild MB splitting (mean±standard deviation, 0.18±0.12 cm) in only 16 cases with age-related cerebral atrophy. Among the 21 patients with complete MR imaging and ETV data sets, 12 ETV procedures were hindered by anatomical anomalies such as a thickened TVF or an “upward ballooning” phenomenon. On preoperative MR imaging in these 12 patients, there was an increased IMD (0.55±0.41 cm) compared with that in the remaining 9 patients (0.27±0.25 cm) who had a normal thin TVF during ETV and in the control group (0.03±0.08 cm). Magnetic resonance imaging and

ETV data concordantly displayed nonsplit MBs in 6 of 9 cases with a thin TVF and split MBs in 10 of 12 cases with a thick TVF.

Conclusions: The normal configuration of MBs is no measurable IMD, with mild splitting occurring in patients with age-related brain atrophy. In hydrocephalic patients, a thickened TVF was present almost exclusively with an increased IMD on preoperative MR imaging and separated MBs on endoscopic viewing. Large retrospective series are needed to confirm that a preoperative increased IMD is predictive of a thickened TVF during ETV.

Neuropsychological stability after endoscopic third ventriculostomy treatment of longstanding overt ventriculomegaly in adults (LOVA)

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Introduction: Endoscopic third ventriculostomy (ETV) has been considered to be an accepted method in the treatment of Longstanding Overt Ventriculomegaly in Adults (LOVA). In our previous study presented to this Conference (Neuroendoscopy 2007), we explored the neuropsychological aspects of these patients. We presented a review of 25 patients diagnosed with LOVA and found that they do universally badly in all aspects studied. It was important to establish the long term effect of ETV treatment on the psychology of these patients.

Patients and Methods: To identify if treatment with ETV achieves stabilization of patients with LOVA from the neuropsychological aspect, we selected 5 patients from our previous group of 25 patients with a repeated delayed assessment more than one year post ETV and their previous assessment. The same tools, i.e. the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) and the Hospital Anxiety and Depression Scale (HADS) were used.

Results: Regarding the RBANS, there was no significant change in the immediate memory, visuospatial, language, attention and delayed memory. An exception was found in one patient in whom there was a significant improvement of delayed memory. From the HADS point of view, it was noted that there is an increased anxiety in 3 out of 5 patients, while there was inconsistency in the depression results.

Discussion and Conclusion: In our previous study, we showed that ETV yields a significant improvement in the presenting clinical symptoms. There was about 90% improvement of their ICP related symptoms. The long-term neuropsychological effects of ETV have seldom been studied or compared to baseline measurements. ETV treatment in these patients in addition to improving their headaches and ICP related symptoms has not been associated with any deterioration in the neuropsychological aspect of these patients but the numbers are too few to demonstrate any improvement except the one patient in whom there was a positive influence on delayed memory over time. An increased anxiety was noted in these patients with inconsistent change from the depression perspective. Despite the small numbers tested, these results show that ETV is associated with stabilization of the neuropsychology of patients with Longstanding Overt Ventriculomegaly.

Morphological study of the variants of the third ventricle applied to endoscopic neurosurgery

C.E. Gagliardi, L.M. Cuello, P.Z. Maggiora (La Plata, Argentina)

Introduction: Endoscopic neurosurgery has become a standard tool for the treatment of a great number of pathologic entities which involve CSF circulation cavities. Particularly frequently the procedures performed inside the third ventricle are. Morphological variants in the ventricular cavities are common findings, the occurrence and the significance of them must be taken in consideration.

Materials and methods: A detail analysis in a series of 484 procedures was performed. The patients included in this study suffered from obstructive hydrocephalus, malformations, and tumours, in relation to the last group, biopsy or resection were done. Every procedures were recorded and each variation was quantified, and the significance for the adequate performance of the operation was assigned.

Results: The most frequent anatomical variation was the opacity of third ventricle floor (19.7%); other important ones were; a basilar artery indented the ventricular floor (30%), translucent and thin floor (4.9%), abnormal arteries (0.7%) aberrant commissures (0.7%), and a great massa intermedia avoiding the expansion of the ventricle in the context of hydrocephalus (0.3%).

Conclusions: Beside the scope of anatomic distortions created for the great diversity of pathologic condition associated to the endoscopic neurosurgery of the third ventricle, a lot of anatomical variations exist, those patterns are not only frequent, they have a great importance for the good performance of different procedures, and typically they are conditioning factors for the selection of one technique rather than another.

Analysis of the endoscopic technique in the treatment of hydrocephalus: 14 year experience

G. Fernandez Molina, R. Jaimovich, D. Dosvaldo, J. Bocchiardo (La Plata, Argentina)

Introduction: Endoscopic ventriculostomy has shown to be the correct procedure in the treatment of obstructive hydrocephalus with well-functioning subarachnoid spaces. Other types of complex hydrocephalus have also seen the benefits of the neuroendoscopic techniques which provide a simple solution to some complex cases. In this type of patients we can resort to septostomy, Monroplasty, aqueductoplasty, septal fenestration, choroid plexus coagulation, catheter removal/ placement. A 14 year experience in the neuroendoscopic treatment of these conditions is presented.

Material & Method: Between July, 1995 and June, 2008, and over a total of 451 neuroendoscopic procedures in 346 patients, 333 neuroendoscopic procedures for the treatment of hydrocephalus were carried out in 273 patients. We performed 171 third ventriculostomies, 44 septostomies, 36 patients underwent septal fenestration, 31 patients underwent catheter placement, in 28 patients the catheter was removed, 14 Monroplasties were carried out as well as 9 aqueductoplasties. All patients were operated under general anaesthesia and a rigid neuroendoscope was always used, except in 9 aqueductoplasties in which a fiberscope was also used. **Results:** Postoperative follow-up included CT or MRI studies. In 245 out of the 273 operated patients the treatment was effective and in 28 cases it was required to place a shunt. 9 patients with a previous history of meningitis and multiple shunting, developed a postoperative meningitis which responded positively to medical

treatment. 4 patients suffered from temporary hemiparesis and in 3 cases, the patients showed temporary diplopia. None of the patients died.

Conclusions: For 14 years of personal experience and in agreement with the published scientific literature, we believe that this technique has shown to be not only very useful in cases of obstructive hydrocephalus, but also in cases of more complex hydrocephalus, through a wide variety of possibilities and high level of effectiveness and considerably low risk.

Neuroendoscopy in multicompartimental hydrocephalus

J.F. Ramon (Bogota, Colombia)

Objective: Most of the patients with multicompartimental hydrocephalus are the result of neuroinfections (ventriculitis and meningitis) that can be a first manifestation or secondary to infections of ventriculoperitoneal or ventriculoatrial shunts. This leads to multiple surgeries and the use of different shunts systems with the objective of draining each cavity separately. The neuroendoscopy in these cases arises as an adequate alternative treatment since it permits that the septums communicate and in some patients it is possible to make a third ventriculostomy depending on the anatomic changes found. Its use helps to avoid the use of shunts or at least gives a better option of leaving just one system to drain all compartments.

Methods: A series of cases of 60 patients that where operated between October of 2006 and December of 2008 with a diagnosis of multicompartimental hydrocephalus, with ages between 1 month and 21 years old, to whom rigid neuroendoscopy was done to break the septums, separate communication of ventricular system, removal of multiple shunts and in some cases the third ventriculocisternostomy.

Results: 43,3% were children under 2 years old, 53,3% between 2 and 10 years old. 69,5% of the patients had between 2 and 5 previous neurosurgeries, 18,6 more than 5, finding that 25,4% had one catheter at the moment of the neuroendoscopy, 55,9% with two catheters and 10,1% with three catheters. Only one case (1,7%) presented as a complication bleeding, needing to be reoperated in two opportunities.

Conclusions: Neuroendoscopic fenestration of ventricular septums in multicompartimental hydrocephalus is an adequate method for the reduction of the number of catheters used in these patients, permitting in some cases the removal of shunt systems.

Incomplete size reduction but complete clinical recovery, in patients with ETV after years of shunt dependency

Lj. Vujotic, D. Grujicic, D. Radulovic, V. Bascarevic, I. Piscevic (Belgrade, Serbia)

ETV has been accepted as the first procedure in treating most of hydrocephalic patients, but still there are few studies showing its efficiency after shunt procedures, especially in cases of early shunt placement (under 6 months). The purpose of this study was to analyze ventricle dimension reduction after ETV, after years of shunt dependency.

Material: We have analyzed data for 30 patients who underwent ETV+shunt extraction, instead of shunt revision, operated 1998–2008, using rigid endoscope. CT or MRI performed preop, ventricle diameter measured preop, one month, 3 months and one year after surgery.

Results: All cases of obstructive hydrocephalus, 17F/13M, mean age 22 years, mean period of shunt dependency was 15,6y. Preoperative FM/ID index (frontal horns/inner diameter at caput nuclei caudati level) was 0,53, FM/PM (frontal/largest parietal internal diameter) was 0,41. After ETV very slow reduction of ventricle size was shown, significantly different from patients treated by VP shunt, but ETV was followed by clinical recovery, no signs of increased ICP, (in 30% of cases with papilloedema slowly reduced in period up to two months). One month after ETV, the reduction was poor, 3 months later still not complete, and even after one year later not normal (FM/ID was 0,48 and FM/PM 0,35), but other signs of hydrocephalus reduction, (no periventricular perfusion, cortical spaces visible, neuroophthalmologic recovery) were present. We can conclude that slow and incomplete reduction of ventricle size after ETV, especially in early placement and years of shunt dependency, is not the parameter of ETV insufficiency, if other signs of improvement are present (no periventricular perfusion, visible sulcuses), good neuroradiological finding (papilloedema reduction, no oculomotor disturbances), and clinical recovery. Dynamic studies of CSF showed stoma patency. Adequate absorption process needs time to establish. So, this slow reduction of ventricle size after ETV should be expected and considered normal, and some moderate arrested hydrocephalic appearance shouldn't be considered as failure of ETV. Previous studies showed in all ETV patients slow reduction of ventricle size, and this is especially the case for those with long shunt dependency period, and those with early shunt placement.

Endoscopic interventions in obstructive hydrocephalus

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Introduction: The role of endoscopy in treating obstructive hydrocephalic conditions is rapidly growing and indications are increasing. Our experience in the variety of pathological entities causing obstructive hydrocephalus is being reported, and the effectiveness of endoscopic treatment is being evaluated.

Material and methods: This is a retrospective study. It includes 55 patients (male/female ratio: 23/32) treated in the last 9 years. Age ranged from 43 to 89 years. The follow up period ranged from 4 to 36 months. 50 patients presented with triventricular hydrocephalus (30 with aqueductal stenosis, 15 with tumour, and 5 with intraventricular cysts), while 5 had isolated ventricles. All patients were evaluated with MR and phase contrast cine MR scans both pre- and postoperatively. We operated these patients using a rigid ventriculoscope long version system (Aesculap, Tuttlingen, Germany) with neuropilot IV stabilizing system. The operation was considered successful upon symptoms regression and normalized CSF circulation on cine MRI, and the patient not needing further intervention at a later time.

Results: ETV was performed in 44/45 patients with triventricular hydrocephalus. It wasn't possible in one case, due to limited space on the 3rd ventricle floor. Septostomy and/or fenestration was performed in the isolated ventricle group. Where a tumor was present a biopsy was taken. Partial excision was possible in 6 cases of ventricular and paraventricular tumors. Intraventricular cysts were treated with fenestration and ETV. In 37/44 (84%) patients CSF flow was reconstituted, as demonstrated by cine MRI. 34 (77%) of them showed neurological improvement, the

other 3 showed no change. 7/44 patients represented with hydrocephalic phenomena after the first treatment. In 5 of them cine MRI demonstrated reocclusion and they required a second ETV procedure. That was successful in 5/5. The other 2 patients were shunted. In total, 39/44 (89%) patients improved both clinically and radiologically, of which 5 after a second procedure. No major complications appeared in the study group. 3 patients had transient memory loss that improved within 2–5 months.

Conclusions: We affirm that endoscopic treatment of obstructive hydrocephalus of various origins is safe and effective. To our opinion, it should be considered as a first line treatment. However, careful patient selection and effective fenestration are key elements to its success.

Pituitary Tumours - Craniopharyngioma

Results of endoscopic endonasal transphenoidal surgery for acromegaly

E.J. van Lindert, J.A. Grotenhuis, M.A.E.M. Vegt-Wagenmakers, R.T. Netea-Maier, A.R.M.M. Hermus (Nijmegen, The Netherlands)

Background: The endoscopic endonasal transphenoidal approach (EETA) is becoming increasingly popular and replacing the microscopic transphenoidal approaches for pituitary tumors. Endocrinological results, however, are still sparse and the microsurgical approach is still the golden standard.

Objective: To evaluate the results of EETA in acromegaly and compare these with reported results of the microsurgical approach.

Methods: A retrospective study of all charts and laboratory results of all patients with acromegaly operated by EETA since its introduction to the department in 1997 was performed. 47 patients were included (25 female) of which 40 (85%) had a macroadenoma. Intentional curative surgery was performed in all but 4 patients, in whom only partial removal was intended. Remission was defined as normalization (age and gender adjusted) of IGF-1 and GH-suppression <2 mE/L in the OGTT.

Results: Remission of acromegaly was reached in 51% of all patients and 50% of the macroadenomas. The cure rate for macroadenomas was 33% in the first 5 years and 64% in the last 5 years. If the 4 patients with intentional partial removal are excluded, the cure rate increased to 78%. In 33% of patients 1 or more pituitary axes were hormonally substituted, but the number of new postoperative hormonal deficits and the number of postoperative improvement of pituitary deficiency were equal.

Conclusion: The results of EETA in acromegaly are comparable to that of the microsurgical approach. However, the learning curve of the EETA shows a tendency towards an improvement of the remission rate.

Endoscopic pituitary surgery with the Minop trend system

J.A. Horaczek, A. Joedicke (Berlin, Germany)

Introduction: Endoscopic transphenoidal approaches are increasingly used in the neurosurgical treatment of processes of the sellar region. This report reviews the transition from a purely microsurgical to an endoscopic approach for transphenoidal pituitary surgery in a mid-sized neurosurgical centre.

Material and Methods: Over a period of ten years, patients undergoing transnasal pituitary surgery in a mid-sized neurosurgical

unit are reviewed. Special emphasis is given to selection criteria for either microsurgical or endoscopic surgical approaches. We compare the duration of the procedures and hospitalization times as well as complication rate and postoperative outcome in relation to the level of experience of the centre in the field of transphenoidal endoscopy. Advantages and potential for technical improvement of specifically designed transphenoidal endoscopes such as the MINOP-Trend system are discussed. Possible implications of a more general introduction of this new technique into neurosurgical practice for neurosurgical training are discussed.

Results: Over a period of 10 years, the annual number of patients undergoing transphenoidal surgery increased by about 30%. The relation of microsurgical vs. endoscopic approaches inverted from about 9:1 to 1:9. Average duration of hospitalization decreased from 7 to 4 days using an endoscopic approach. Endoscopic pituitary tumour resection recurrence and complication rate seems to be significantly reduced but time for surgery is still increased even after substantial training. There seems to be a higher risk of CSF leak with endoscopic approaches.

Conclusions: Transphenoidal surgery should primarily be performed using an endoscopic approach due to increased surgical success, improved patient satisfaction and reduced duration of hospitalization. There is potential to increase surgical safety and decrease complication rate although there seems to be a slightly higher rate of intra-operative CSF leakage. The use of a special transphenoidal endoscopy system like the MINOP-Trend is advisable. Endoscopic transphenoidal approaches should be included in specialized neurosurgical training programs bearing in mind that the time to achieve satisfactory technical expertise is longer than with other techniques. Nevertheless the use of the technique should be concentrated in the hands of specialized teams.

Endonasal endoscopic transphenoidal surgery: the patient's perspective

E.J. Van Lindert, J.A. Grotenhuis (Nijmegen, The Netherlands)

Background: One of the reasons for the endoscopic endonasal transphenoidal approach (EETA) to become popular is that this approach is considered to be less traumatic and therefore more comfortable for the patient than the microscopic transeptal and sublabial transphenoidal approaches for pituitary tumours. This opinion, however, has not been substantiated.

Objective: To evaluate the discomfort and nasal airway problems encountered by patients after EETA.

Methods: A telephonic or face-to-face interview of all patients operated by a single neurosurgeon (EL) between January 2002 and December 2005 was performed. In this period 95 patients were operated of whom 87 could be interviewed (92%). 83 of these had undergone a binostril approach and 4 an one-nostril approach. M/F-ratio is 1.07, average age 48 (12–74) years. Eight patients received postoperative radiotherapy.

Results: Mean follow-up period was 3.8 years. The postoperative VAS was 3.3+2.4 SD. Recovery of nose complaints was within one week in half of the patients, while this took more than 3 weeks in 10 patients. New headache in 7 patients (8%). No or mild direct postoperative discomfort in 63 (72%) and moderate to severe discomfort in 24 (28%). Postoperative nasal airway obstruction

in 12 (14%) of which 7 only mild. Decreased smell in 15 (17%) of which 12 mildly decreased. Ozaena in 5 (6%, 1 due to radiotherapy), nose bleeds in 3 (of which 1 due to psoriasis). Increased snoring in 11 (13%) and decreased snoring in 9 (10%). Nasal crusts in 16 (18%) and chronic rhinitis in 8 (9%). Eight patients visited a otorhinolaryngologist, two of whom for unrelated causes (tinnitus), none of them required corrective endonasal surgery.

Conclusion: The impression that rhinological problems after EETA are few and infrequent is confirmed by this study.

Closure methods for extended endoscopic transphenoidal approaches

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Introduction: Closure of the dural and bony defects, with subsequent increased risk of postoperative cerebrospinal fluid (CSF) leak is one of the important challenge in extended approaches and much more complex closure should be done than standard approaches.

Material and Methods: 230 pure endoscopic endonasal transphenoidal operations were performed between September 1997 and December 2008 in Kocaeli University, Department of Neurosurgery. We describe our closure methods in extended approaches which were performed for 20 patients for the last five years. Multilayer techniques have been used to close the defect following the closure of sella floor and posterior sphenoid sinus wall. After positioning fat graft covered by dural graft in the intradural space and a bone graft have been used considering the borders of bone as a solid barrier between the intra- and extradural compartments. Reconstruction have been continued by multiple layers of dural grafts and by mucosal flap with its pedicle slipped from original nasal septum. Surgical glues have been used to fill the sphenoid cavity and hold the repair in place. In some cases a Fogarty catheter (12–14 French) have been inflated in front of the opened sphenoid sinus. In the first group of patients which includes 11 patients lumbar drainage was not used, but in the second group of patients which includes the last 9 patients lumbar drainage was performed intraoperatively.

Results: Follow up period was between 2 months and 44 months (median: 2.3 months). Postoperative CSF fistula was seen in 4 patients and 1 of them needed reoperation due to CSF fistula in the first group (4/11, 36.3%). Only in one patient CSF leakage was seen for two days but did not need any operation (1/9, 11.1%).

Conclusion: Following tumor removal, effective dural closure should be performed to avoid postoperative CSF fistula in extended approaches. CSF fistula rates can be decreased by performing lumbar drainage.

Role of endoscopic endonasal surgery for pituitary adenomas

C.E. Deopujari, N. Shah (Mumbai, India)

Transphenoidal surgery for pituitary tumour was successfully employed by Cushing in earlier times (1912). However, he later shifted to the transcranial approach followed by most other neurosurgeons. With better imaging, use of C-arm fluoroscopy and the use of microsurgical technique, transphenoid surgery

was revived by Hardy in 1967. Griffith described the direct endonasal approach in 1987. Though endoscopy was used in transnasal surgery by Guiot earlier (1972), the endonasal endoscopic technique has evolved only in the last 15 years as the choice of approach. Most of the pituitary tumours can be tackled now by the transphenoidal approach. Our preference for the use of the endonasal endoscopic or assisted approach has evolved over the last 8 years in around 284 procedures where purely endoscopic endonasal approach was used in 206 cases of pituitary adenomas and microscopic assistance was sought in another 78 cases. Transcranial approach was used in 29 cases. Endoscopic transphenoidal and extended cranial base surgery is a minimal access, maximally aggressive emerging alternative to traditional transfacial, transcranial or combined open cranial base approach for these tumours.

Prospective comparative study on 50 patients between microsurgical sublabial transphenoidal approach and endoscopic endonasal transphenoidal approach

J. Ensenat, M. De Notaris, J. Aparicio, L.M. Cavallo, S. Candela, E. Ferrer (Barcelona, Spain and Napoli, Italy)

Objective: Compare the standard transphenoidal sublabial microscopic approach with the endoscopic transphenoidal approach concerning the tumoral invasiveness and resection, complications of the approaches and time of postoperative hospitalisation.

Material and methods: We realized a prospective, non-randomised study with 50 patients. They were operated between 2002 and 2006. All the patients had pituitary macroadenomas with different grades of invasiveness of the cavernous sinus as classified by Knosp. The variables included in our study were tumoral invasiveness and operative resection (total, subtotal and partial), optic nerve lesion, postoperative panhypopituitarism, CSF fistula, cranial nerves deficits, epistaxis, meningitis, diabetes insipidus and carotid artery lesion. Our series included 27 males and 23 females ranging from 19 to 80 years old (48 mean). In 23 patients we used the standard sublabial microscopic approach (two patients were excluded) and for 25 patients we used the endoscopic approach. The mean follow up were of 12 months.

Results: In our experience the endoscopic technique presents a higher percentage of total resection comparing to the sublabial microscopic approach (60% versus 34,8%) and higher percentage of subtotal resections (32% versus 26%) with a statistically significant difference ($p=0,033$). The time of hospitalisation was significantly shorter for the endoscopic approach group ($p=0,001$), diminishing by half of the time (3 days) of the microscopic approach group. Concerning the tumoral invasiveness and complications we did not appreciate any significant dissimilarity. We appreciated that a higher grade of invasiveness augments by 3, 59 the risk of an unsuccessful surgery.

Discussion and conclusion: In our experience the endoscopic technique may favour a better tumoral resection and shorter time of hospitalisation. We did not appreciate differences concerning the complications.

Improved resection rate with use of angled optics in endoscopic sellar surgery

J. Oertel, M.R. Gaab (Mainz and Hannover, Germany)

Objective: While a higher resection rate with endonasal endoscopic techniques often is claimed, evidence that the endoscopic technique leads to superior results is still missing.

Material and Method: Between October 2000 and January 2008, 189 patients (93 males, 96 females, mean age 58 yrs [range 23–83 yrs]) received 197 endoscopic endonasal transphenoidal procedures for perisellar lesions. The surgical technique was carefully analyzed. Special attention was paid to the application of various angled optics and the influence of their application to achieve a higher resection rate.

Results: Lesions consisted of 155 macroadenomas, 25 hormone producing adenomas, 5 Rathke's cleft cysts, 2 clivus chordomas, one mucocele and one fronto-basal encephalocele. All procedures were performed with 0° optics. 30° and 45° optics were used for assessment of resection radicality. In eight recurrent cases, tumour regrowth was observed on follow up. Mean surgical time scored 104 min (range 45–220 min). In 134 cases of all patients (68%) radical tumour resection was intended at surgery. Intraoperatively, the various angled optics were applied in 143 procedures (73%). In these cases, remnant tumour tissue only discernible by the angled optics was found in 35 of 143 cases (24.5%). These tumour remnants were removed in all cases subsequently. On follow up (2 weeks to 6 years; mean 3.65 year), MRI revealed radical tumour resection in 121 cases when intended (90.3%). Recurrent tumour growth was observed in 8 younger patients (4.2%) and subsequent surgery was required. There was no mortality. Perioperative morbidity scored 6.6% (13 out of 197).

Conclusion: In all, the authors consider the transnasal endoscopic approach the technique of choice for sellar tumours. Particularly application of the various angled optics allows identifying tumour remnants in the carotid area which can be removed under endoscopic view leading to higher resection radicality.

Endoscopic pituitary surgery: preliminary experience at the American University of Beirut

M. Najjar, G. Haddad, U. Hadi (Beirut, Lebanon)

Object: To study our preliminary experience in endoscopic transphenoidal resection of pituitary tumours, and assess the outcome of our surgeries.

Methods: We review from a prospective database our series of 14 consecutive patients, harbouring pituitary tumours, and operated via the endoscopic transphenoidal approach, over the past 2 years. We describe our surgical technique, including the use of the endoscope holder, and various other tools.

Results: Our preliminary experience was very encouraging, with total removal of the tumour in most patients and minimal complications. The average hospital stay was 3 days. The surgery was not converted to the microsurgical technique in any patient.

Conclusion: The transphenoidal approach to pituitary tumours has become the standard surgical route for most pituitary adenomas. Although microsurgical transphenoidal surgery is still largely popular, endoscopic surgery is quickly climbing to be the first choice in surgical management of pituitary tumours. Endoscopic removal of pituitary tumours is a rapidly rising technique that affords better visualization of the tumour bed at surgery, shorter hospital stay, and less nasal complications and discomfort, when compared to the routine microsurgical technique.

Endoscopic surgery for pituitary adenomas: analysis of over 100 consecutive cases from a prospective database

S. Tjoumakaris, M. Rosen, J. Evans (Philadelphia, USA)

Introduction: Recent advancements in the endoscopic approach to the pituitary have resulted in the ability to approach essentially all lesions in this manner. We report a series of over 100 consecutive patients undergoing endoscopic resection of pituitary adenomas. Our outcomes, complications and refinement of the technique are discussed.

Methods: A prospective database was analyzed for multiple variables including patient presentation, endocrine evaluation, ophthalmology data, surgical resection, complications and outcomes. Appropriate statistical tests were used, as determined by the distributions of the dependent and independent variables of interest.

Results: The group consisted of 96% macroadenomas and 4% microadenomas. In total, 78% were non-functional and 22% functional adenomas. On presentation 58% of patients had visual loss of which 90% experienced visual improvement postoperatively. Normal vision was restored in 71%, and vision was improved significantly in 19%. There were no cases of visual deterioration as a result of surgery. Transient diabetes insipidus occurred in 9.6% of the patients, but none were permanent. Aside from the need of temporary cortisol replacement, no new endocrinopathies were identified postoperatively. There were three cases of postoperative cerebrospinal fluid rhinorrhea, only one of which required re-operation for repair. Total resection was achieved in 70% of patients, near total resection in 25%, and partial resection in 5% by radiographic criterion. The mean and median hospital stays were 4.0 and 3.0 days, respectively.

Conclusion: We find that endoscopic transnasal surgery is an effective means of treating pituitary adenomas with minimal complications and outcomes equal or better than historical reports. We compare the data of our early experience versus our later experience in order to describe the refinements in technique and lessons learned during the development of our endoscopic endeavour. We expect this technique will become widely used as a standard in the management of pituitary adenomas. Learning Objective: By the conclusion of this session, participants should be able to: Describe the application, complications and outcomes of endoscopic transnasal pituitary tumour surgery.

Endoscopic transphenoidal endonasal approach for large pituitary adenoma with extra/parasellar extension

A. Ayyad, C. Charalampaki, A. Perneczky (Mainz, Germany and Graz, Austria)

Introduction: The transphenoidal route is a direct and rapid extracerebral approach to the sellar region, and therefore, it is the most widely used technique for the processes involving this area. Since its introduction in 1907 it has been subjected to tremendous developments. The endoscope is the latest innovation in the field of optical instrumentation; it allows the surgeon's eye to penetrate the depth and width of the access route.

Methods: During 4 years between Dec.2003 till Dec.2007 we have operated 61 patients with large pituitary adenoma, 13 with giant adenoma; 32 males, 29 females; 12 had hormone active tumours (8 GH, 2 Prolactinoma, 2 ACTH), 49 with hormone inactive. Most patients presented with visual disturbances.

Results: total excision was achieved in 50 patients. From 12 patients with active adenoma 9 were cured, 3 has residual activity. 3 Patients developed recurrence, 2 patients developed postoperative bleeding, 3 patients had postoperative CSF rhinorrhea; 85% of patients with visual disturbances showed improvement.

Conclusion: The minimum traumatization of the nasal cavity without nasal retractor, the optical advantages of the endoscopic visualization in anatomical orientation and tumour removal and the early postoperative improve of the patients without nasal packing are obvious advantages of the endoscopic binostril technique.

Image-guided pure endoscopic endonasal binostril approach for resection of giant pituitary adenoma

P. Vacek, V. Hrabec, J. Mracek (Plzen, Czech Republic)

Introduction: The evolution of endoscopic endonasal transphenoidal approach for resection of the sellar lesions has led to possibility to remove from the nose even giant adenomas. This route allows sufficient access and visibility without brain retraction.

Objective and methods: Last year 8 patients with giant pituitary adenoma were operated in our department upon using an image-guided pure endoscopic endonasal binostril approach without nasal speculum. 6 patients had non-functional adenoma and 2 patients were suffered from acromegaly.

Results: Total tumour removal was achieved in 6 patients, subtotal in 2 patients. There were 3 intraoperative and 0 postoperative CSF leaks. 3 patients developed postoperative transient diabetes insipidus. Epistaxis and airway difficulties were never observed.

Conclusion: The image-guided pure endoscopic endonasal binostril approach is a form of minimally invasive surgery offering sufficient view and space for safe removal of giant pituitary adenoma.

Endoscopic cavernous sinus surgery in pituitary adenomas

G. Frank, E. Pasquini, D. Mazzatenta, M. Zoli (Bologna, Italy)

Introduction: The authors report the experience in endoscopic endonasal cavernous sinus surgery in pituitary adenomas. The attention is focused on pituitary adenomas because they are the most representative and homogeneous group of pathologies invading the cavernous sinus and there are well established criteria to evaluate the results making the present series comparable with previously reported series.

Material & Method: Between May 1998 and January 2008, 681 patients affected by pituitary adenomas underwent an endoscopic endonasal procedure at the "Bellaria" Hospital of Bologna; 107 (15.7%) of them showed an invasion of one or both cavernous sinuses. Fifty-nine (55%) were male and 48 (45%) were female. Age ranged from 18 to 77 years (mean: 50; median 51). The follow-up ranged from 6 to 102 months (mean 30 median 23).

Results: The procedure was well tolerated. There was no perioperative mortality. Patient hospital stay was between 2 and 91 days (median: 4 days). Early and delayed results are presented. Complications were few and are reported in detail.

Conclusions: Our experience suggests that for pituitary adenomas invading the cavernous sinus and having an extradural location, the endoscopic endonasal approach is the elective procedure. It allows to confirm the diagnosis, to obtain in some cases the cure

of the patients, to improve the symptoms and to make more safe and effective a medical and radiation therapy.

Endonasal endoscopic approach in pituitary adenomas

L. Arbolay Omar, G. Gonzalez Justo (La Habana City, Cuba)

Introduction: Surgical excision is the first option in the treatment of many pituitary adenomas and the transphenoidal approach is the method that is most frequently used. Recently a refinement of this operation, the endonasal endoscopic technique, has been introduced in many centres. The objective of the present study was to evaluate our results using the endoscopic endonasal approach.

Material and methods: We prospectively studied 100 patients in whom we used this technique between January 2003 and September of 2007 in the Neurosurgical Department of the Hermanos Ameijeiras Hospital in Havana.

Results: Seven three (73) patients had pituitary macroadenomas and twenty seven (27) had microadenomas. Forty seven (47) were functioning adenomas (24 GH, 21 ACTH and 2 PRL) and fifty three (53) were non-functioning. We achieved gross total resections in 86% of the cases and subtotal resections in 14%. Complications occurred in seventeen patients (17%) ten of whom developed diabetes insipidus. There were no deaths.

Conclusion: We conclude that the endoscopic endonasal method is a safe and valuable addition to the neurosurgical armamentarium and is likely to become the favoured surgical approach in the treatment of pituitary lesions.

Preservation of normal pituitary gland in endoscopic transphenoidal surgery for intrasellar and suprasellar lesions

A. Alias, N. Ariffin, M.Saffari (Kuala Lumpur, Malaysia)

Introduction: The term ‘hypophysectomy’ should be used no longer in modern treatment for pituitary macroadenoma and other intrasellar and suprasellar lesions especially in patients with preoperative normal pituitary hormones. The problem is the lesion but not the normal gland. Therefore, attempt should be made to remove the pathological lesions aggressively but at the same time to preserve the potentially functioning pituitary gland thus avoiding a life long hormonal replacement therapy for the patient. We describe our prospective study and techniques in preserving normal pituitary glands functions in endoscopic transphenoidal surgery for intrasellar and suprasellar lesions

Methods: From 2006 to 2008, a total number of 18 patients with intrasellar or suprasellar lesions with preoperative normal pituitary hormonal level prior to endoscopic transphenoidal surgery at Department of Neurosurgery, Hospital Kuala Lumpur, Malaysia were included in the study with the aim to preserve the function of normal pituitary glands and avoiding long term postoperative hormonal replacement therapy. The pathology includes Nonfunctioning Pituitary Macroadenoma (8), Acromegaly (2), Cushing Disease (1), Prolactinoma (1), Arachnoid Cyst (1), Rathke’s Cleft Cyst (1), Craniopharyngioma (1), Meningioma (3). A combined Neurosurgeon-Otorhinolaryngologist with binostrials - 4 hands techniques were used in all cases. In small sellar lesions, the position of normal functioning pituitary gland were predicted from preoperative MRI study based on few characteristics on the Sagittal plane 1) Most of normal gland appears isointense on T1 weighted, usually

crescentic in shape as it is compressed posterior-superiorly by the tumour 2) Enhanced following gadolinium contrast injection. 3) The direction of the pituitary stalk which lead to the possible normal pituitary gland could be predicted by tracing the position of mamillary body and infundibular recess as it continue downwards as a pituitary stalk. For soft tumour with superior-posteriorly located gland, we advocate intracapsular dissection, with the initial step to curette the tumour inferiorly towards clivus first and preserving the superior capsule as it may represent the compressed normal pituitary gland. A plane between potentially normal gland and tumour were created and other structures including pituitary stalk and hypophyseal vessels were preserved whenever possible. Incision through the normal gland was made in a case of suprasellar Rathke’s cleft cyst. However we preferred extracapsular dissection for firm to hard tumour such as meningioma.

Results: A potentially normal pituitary gland was identified and preserved in 16 cases (88%) while the normal pituitary function preserved in 15 cases (83%).

Conclusion: The preservation of pituitary gland in endoscopic transphenoidal surgery for intrasellar and suprasellar lesions is possible in most of the cases with preoperative normal pituitary hormonal level, thus eliminating the drugs dependency following endoscopic transphenoidal surgery in selected number of patient with intrasellar and suprasellar lesions.

Decision making in skull base surgery - transnasal or transcranial

M. Bettag, P. Schaefer, C. Busert (Trier, Germany)

Introduction: In this study, we examined the feasibility of endoscopic transnasal techniques in the treatment of different skull base tumours with extradural and intradural extension.

Methods: 160 patients with sellar and parasellar tumors were treated in our department by pure endoscopy-controlled binasal - transphenoidal surgery between October 2000 and December 2007. Among these patients, there were 145 pituitary adenomas with 121 macroadenomas and 24 microadenomas. There were 41 endocrine active tumours and 19 recurrent pituitary tumours. Apart from pituitary tumours, 4 clival chordomas, 3 Rathke’s cysts, 3 craniopharyngiomas, 2 colloid cysts, 1 hypophysitis, 1 fibrous dysplasia and 1 pilocytic astrocytoma were treated. In the clival chordomas, fibrous dysplasia, craniopharyngeomas and the pilocytic astrocytoma, we used extended skull base approaches (transclival, transplanum, transthemoid) and image-guidance (neuro-navigation) as well as specific reconstructive techniques (neurovascular pedicled flap).

Results: In pituitary tumours, the overall gross tumour resection rate was 78,6% (114/145). The main complication was CSF leak in 5,5% (8/145). There was a very low rate of permanent diabetes insipidus with 1,3% (2/145). In the extended skull base approaches, the rate of CSF leak was higher with 16,7% (2/12). There was no mortality in all of the patients.

Conclusions: Endoscopic transnasal surgery is a safe technique in treating most of the skull base tumours located intra- and extradurally at the ethmoid plate, planum sphenoidale, sella and perisellar area and the clivus. Advantages are the direct approach to the tumour attachment zone, tumour resection techniques with no retraction of the brain, endoscopic visualisation of the neuro-

vascular structures at the skull base and control of the extradural carotid artery.

The role of endoscopic endonasal surgery in the treatment of craniopharyngiomas

D. Mazzatenta, E. Pasquini, F. Calbucci, M. Zoli, G. Frank (Bologna, Italy)

Aim of the study: The aim of our study is to verify the role of endoscopic endonasal surgery in the treatment of craniopharyngiomas
Material & Method: We reviewed the surgical series of patients operated on for craniopharyngiomas at Bellaria Hospital of Bologna (Italy) during the last ten years (January 1998–December 2008). Ninety-two surgical procedures were performed in 69 patients. Endoscopic endonasal procedures were a little less than the half of all procedures.

Results: The graphic of the procedures over time shows an increasing trend on the use of the endoscopic endonasal surgery and a decreasing use of the craniotomy approach. The two groups of patients (endonasally treated and craniotomy treated) were comparable for size and location of the tumor. Surgical results (entity of tumor removal, symptoms improvement, quality of life) showed no significant difference.

Conclusion: Being results comparable, we believe that in selected cases the endoscopic endonasal procedure should be preferred, because it is less traumatic and better tolerated. We also suggest that it should be performed by neurosurgeons skilled in the endoscopic technique at Centers where all types of surgical procedures can be performed.

Extended endoscopic endonasal approach for craniopharyngiomas

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Suprasellar craniopharyngiomas have been historically removed through a variety of extensive transcranial approaches. In recent years, the increasing interest for minimally invasive surgical techniques and constant improvements in diagnostic tools and surgical instruments, above all the advent of the endoscope in transphenoidal surgery, have led neurosurgeons to consider the extended endonasal transphenoidal route for the management of such lesions. Between January 2004 and October 2008 sixteen male and five female subjects (mean age 53.2 years; range 13–68) underwent surgery for craniopharyngiomas, including three intrasuprasellar, five suprasellar, nine suprasellar/intraventricular and four purely intraventricular craniopharyngiomas. The surgical technique consisted in an extended endoscopic transphenoidal transtuberulum/transplanum approach via different surgical corridors, namely the supra and subchiasmatic and the retrosellar. Total removal was achieved in ten patients, whereas near-total and partial removal were possible, respectively in eight and in three patients. All patients with visual field and/or visual acuity defect improved, except in one case in which we observed a further slight worsening of visual acuity in one eye. Preoperative pituitary dysfunction did not improve in any patient. In three cases, the new occurrence of a permanent diabetes insipidus was observed. Concerning the complications, five patients developed a postoperative CSF leak, requiring a successful endoscopic revision of the cranial base reconstruction. One patient died five weeks later because

of hypothalamic dysfunction. Differently from the transcranial technique, the extended endoscopic endonasal approach for suprasellar craniopharyngioma provides a straight, median approach, thus offering the possibility to expose and remove such lesions, without the need of any brain retraction. On the counter part, it should be bear in mind that skull base reconstruction after the extended approach for craniopharyngiomas still stands as a challenging matter. Nevertheless, surgeon's experience and improvements reconstruction techniques, as well as further technological advancement, are expected to render the extended endoscopic endonasal approach safer and more feasible, thus affording its widespread and figuring out as a valid alternative to the transcranial approaches in selected cases.

Endoscopic assistance in craniopharyngioma surgery

C.E. Deopujari, N. Shah (Mumbai, India)

Endoscope assistance has allowed minimally invasive approaches to be used in craniopharyngioma excision. As the trend in management is shifting from radical to functional surgery, endoscopic techniques have also proved to be a good alternative in palliative surgery. Our experience of 58 cases over last 15 years is presented with special emphasis on endoscope assisted surgery. Endoscopic endonasal transphenoidal approach has allowed us to remove infradiaphragmatic craniopharyngiomas radically with safety. Supradiaphragmatic tumours may be suitable sometimes for extended transphenoidal approach. 10 patients were treated by endoscopic endonasal approach. In other cases minimally invasive supraorbital approach can be effective for radical excision with endoscope assistance through various skull base corridors. Two rare cases of intraventricular craniopharyngioma were treated by intraventricular endoscopic approach for radical excision, while it was used in 6 cases for reservoir insertion.

Neuroendoscopic treatment of cystic craniopharyngiomas

H. Murai, N. Saeki, Y. Hasegawa (Chiba, Japan)

Since 1999, twelve neuroendoscopic operations were made on 13 patients with cystic craniopharyngioma, which extended into the third ventricle. Endoscopic fenestration and partial removal of the cyst wall was made in 12 cases as a first-time treatment. On one patient who had multiple microscopic open surgeries and radiation therapy previously, additional endoscopic and open surgeries was made. Steerable neuroendoscope was introduced through the anterior horn of lateral ventricle on the side where the foramen of Monro was elevated higher. Cyst wall was excised by about 5 mm in diameter, and the content was evacuated and meticulous irrigation was made. Operations were completed within two hours in most cases. Visual and memory impairment recovered rapidly after neuroendoscopic surgery and no worsening cases were noted. Transient fever, headache, and worsening of diabetes insipidus were observed in a few cases and permanent diabetes insipidus was noted in 2 cases. On 2 cases multiple endoscopic fenestration was made. No signs of ventriculitis were observed on the second endoscopic surgeries. In one patient with multiple cysts, recruiting cyst regrowth was observed and outcome was poor. Neuroendoscopic operation for cystic craniopharyngioma is highly effective, safe and less invasive compared to open surgeries. It seems necessary to follow up the patients with or without radiation therapy to consider long-term prognosis.

Positioning of intracystic catheter for craniopharyngioma by a single Burr-Hole endoscopic technique

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Introduction: Almost 90% of craniopharyngiomas have a cystic portion filled with secreted fluid. The direct treatment of the cyst can allow, either in primary or recurrent cases, the control of patients' symptoms and to delay the potentially harmful effects of surgery or irradiation. Surgical resection, open or endoscopic fenestration of the cyst, and intracystic positioning of a catheter with an Ommaya reservoir represent the most commonly reported techniques. The insertion of catheter in the cyst is not devoid of complications, with an incidence ranging up to 16%, independently from the surgical technique used.

Material and Method: Eight patients (mean age: 25.8 years) with symptomatic cystic craniopharyngioma were treated by an endoscopic transventricular approach for the insertion of an intracystic catheter for intratumoral therapy with interferon-alpha. A single right precoronal burr-hole is performed and the frontal horn of the lateral ventricle is accessed under neuronavigation guidance. An armed ventricular catheter was advanced anteriorly to the endoscope sheath through the same cortical access of the endoscope and was guided under endoscopic view down to the cyst dome wall. The coagulated surface of the craniopharyngioma cyst was punctured and the tip of the ventricular catheter was advanced, the depth preoperatively established on MR scans and confirmed by neuronavigation guidance. Hence the proximal end of the cystic catheter was connected to an access chamber to be left in the subcutaneous space and the endoscope was slowly retracted en-bloc.

Results: The procedure resulted efficient and safe in 7 cases. The only complication was represented by one case of technical failure, which occurred in a child with extensive calcification of the cyst dome, endoscopically resulting beyond what expected on preoperative neuroradiological investigations. No leakage neither displacement of the catheter occurred.

Conclusions: Though based on a limited series of patients, the present experience favours the use of neuroendoscopic positioning of intracystic catheters as a safer procedure if compared with open and stereotactic approaches.

Endoscopy helps to understand the physiopathology of the cyst in craniopharyngiomas

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The first description of a craniopharyngioma was in 1857, by Zenker. The term craniopharyngioma was introduced in 1932 by Cushing and has been used widely thereafter. Erdheim was the first to propose the well-accepted hypothesis that craniopharyngioma arises from embryonic squamous cell rests of an incompletely involuted hypophyseal-pharyngeal duct. Because of the infiltrative nature of tumour in the tuber cinereum concern has been expressed that surgical removal could be dangerous. For many years the classification of craniopharyngiomas in to solid, cyst and mixture solid and cyst, when we use endoscopy in only cyst, we see that into of cyst always there is minimal part of solid tumor that produces liquid, but this part of solid tumour doesn't

show in MR. We have forty patients with craniopharyngiomas from 1998 to 2008, (age range 3 to 56 yr), 90% mixture, in 60% cyst, invading the III ventricle and all have infiltration, of floor, and tuber cinereum. When we made endoscopy for first time in cyst we didn't see true capsule, and when we made endoscopy in patient with previous surgery into cyst we saw thick wall. Endoscopy is very useful to understand the mechanism of production of liquid in cystic craniopharyngioma where there is no compact solid tumour with rich vasculature and no desquamative cellular material.

Endoscopic considerations in the ventricular and supraorbital approaches for craniopharyngiomas (minimally invasive surgery...?)

H. Velazquez-Santana, M.A. Barajas, R. Lopez, A. Santana (Guadalajara, Mexico)

Introduction: Craniopharyngiomas are complex tumours due to the effect that they produce in neighbouring structures. The complex nature of cystic, multicystic and solid lesion and the strong adhesion in the hypothalamus-pituitary structures make it hard for surgical treatment. The great variability of current forms of treatment demonstrate the complexity of the tumour and tell us that so far there is no ideal treatment. The advance of endoscopic techniques has resulted in progress in the surgical treatment of these lesions. We present our experience in endoscopic surgical treatment for craniopharyngiomas under the concept of minimally invasive neurosurgery, where the therapeutic effect should be maximum and the damage, should minimum possible.

Material, method, results: We show the considerations related to endoscopic surgical treatment of intraventricular craniopharyngiomas when they invade or compress the third ventricle, as well as related with the supraorbital approach. Cases are presented showing the infiltrative nature of hypothalamic parts of craniopharyngiomas, and the role of that information in the integrated treatment of the patient.

Conclusions: The complex nature of craniopharyngiomas, and its relationship with neuroendocrine structures in the hypothalamic region make it difficult surgical treatment of them. Endoscopy plays an important role in the surgical treatment and defines the correct understanding of the minimally invasive philosophy.

Endoscopic repair of sphenoid lateral recess meningoencephaloceles and CSF leaks via a transpterygopalatine fossa approach

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Introduction: Pneumatization of the sphenoid sinus occasionally includes an extensive lateral recess creating an area beneath the temporal lobe that is relatively inaccessible to surgical intervention. Spontaneous CSF leaks of the middle cranial fossa resulting in CSF rhinorrhea are traditionally repaired via a craniotomy and involve either intra- or extradural repair. We have studied the infratemporal anatomy and have developed an endoscopic transpterygopalatine approach to repair defects involving the lateral sphenoid recess.

Methods: We performed a retrospective chart review of all patients presenting with a spontaneous CSF leak with or without a meningoencephalocele between January 2002 and July 2008 who underwent endoscopic transpterygopalatine fossa repair of lateral sphenoid recess skull base defects. The technique involved

endoscopic ethmoidectomy, maxillary antrostomy, and wide sphenoidotomy to access the lateral face of the sphenoid sinus. Dissection through the medial posterior wall of the maxillary sinus allowed identification and management of the important neural and vascular elements of the pterygopalatine fossa. In particular, the distal internal maxillary artery and the sphenopalatine ganglion and its branches were evaluated. Using gentle lateral mobilization of the sphenopalatine ganglion and the greater palatine nerve we traversed the pterygopalatine fossa to access pathology within a pneumatized laterally extending sphenoid sinus recess. In our series a three layer defect repair was employed in all cases involving the following: Dura-Guard, autologous bone or cartilage, and Duraseal or Tisseal. In addition a lumbar drain for 72 hours post-op was employed in every case.

Results: 11 patients, 7 female and 4 males with an average presenting age of 58.6 (39–80) underwent 12 endoscopic repair procedures. No specific physical or medical condition was associated with the patients' presentation. One patient had a recurrent CSF leak after 9 months and required a second endoscopic procedure. Long term all patients have had a successful repair.

Conclusions: We found that this unique endoscopic approach to treatment of middle fossa skull base defects in patients with a well pneumatized lateral sphenoid sinus both was safe and resulted in durable repair.

Peri- and post-operative complications of FESS: the “Attikon” experience

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Introduction: Functional Endoscopic Sinus Surgery-FESS is a common-spread surgical practice with a widening field of applications extending from chronic rhinosinusitis to skull base surgery. Improvement in techniques and vigorous surgical training has reduced the prevalence of complications. However, even in experienced hands minor or serious complications may ensue.

Aims and scope: To evaluate the prevalence of peri- and postoperative complications of FESS operations.

Patients and methods: 99 patients (51 male-47 female) with a median age of 41.2 years (range 12–68 years) with FESS were evaluated.

Results: Ninety-Three patients (94%) underwent FESS for chronic rhinosinusitis with/without nasal polyps, 3 (3%) for excision of inverted papillomas, 1 (1%) for biopsy of a sphenoid sinus tumor 1 (1%) for sealing a skull base defect and 1 (1%) for acute ethmoiditis with orbital abscess. No mortality was encountered. Bleeding was the most common perioperative complication, affecting 10 patients (10%), but in all cases it was minor, did not involve major arterial branches and thus easily controlled. CSF leak occurred in 2 patients (2%) and the leakage was sealed with a middle nasal turbinate underlay graft. Crusting was the most common postoperative complication, occurring in 14 patients (14%) and it was managed with repeated endoscopic nasal cleaning. Hyposmia occurred in 4 patients (4%), but it was well-tolerated. Aseptic meningitis ensued at the 2nd postoperative day in the patient with the skull base defect attributed to the use of bio-glue, but ultimate outcome following conservative management was favorable.

Conclusions: FESS complications are to be expected even in experienced hands. However, prompt recognition and effective management are the cornerstone of a good outcome.

Skull Base Tumours

Transnasal and transoral approach to midline skull base: Comparison in anatomy between endoscopic and microscopic routes

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Introduction: The midline skull base is a complex structure, boarded from crista galli to the anterior border of the foramen magnum. The goal of this study was to compare the differences in anatomic exposure between microscopic route and endoscopic route, and to define the application of endoscopic transnasal or transoral approach for lesions in the midline skull base.

Material: 10 formalin-fixed adult cadaver heads were injected and used. Three head specimens were dissected by the endoscopic transnasal approach, two head specimens for endoscopic transoral approach, three head specimens for microsurgical transoral transphenoidal approach, two head specimens for microsurgical transoral approach. While full access to midline skull base was approached via transnasal and transoral approaches by using endoscope, the other group was done by microscope.

Results: The extent of exposure under endoscope exceeded that under microscope greatly. A wide vision field of the midline skull base was demonstrated in endoscopic transnasal approach, from the crista galli to the superior edge of axis body, extended to inner wall of orbit and pterygopalatine fossa laterally, all structures were exposed via this approach, specially, complete visualization of carotid and vertebrobasilar arterial systems and all 12 cranial nerves. Structures of the midline skull base was divided into several sub-regions and each part was illustrated separately. In anterior skull base, main landmarks for endoscopic procedure were anterior ethmoidal artery, posterior ethmoidal artery and optic protuberance. In sellar region, important landmarks for endoscopic approach were sellar floor, carotid protuberance, optocarotid recess and clival indentation. In clival region, major landmarks for endoscopic route were clival indentation, pharyngeal tubercle and anterior margin of foramen magnum. In ventral region of craniocervical junction, primary landmarks for endoscopic transnasal or transoral procedures were pharyngeal open of auditory tube, anterior tubercle of atlas, anterior margin foramen magnum and apex of dens.

Conclusion: The extent of exposure in midline skull base showed significant differences between endoscopic procedures and microsurgical ones.

Use of vegetable (*Ricinus communis*) polymer for skull base reconstruction in extended endoscopic endonasal neurosurgery

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Introduction: In the last decades endoscopic endonasal neurosurgery has experienced a great evolution. With the constant expansion of limits, skull base defects have also grown in size and morbidity. The goal in skull base reconstruction has been to

prevent CSF leak, diminishing postoperative morbidity and mortality.

Material: In this study we present seven cases of extended endoscopic endonasal neurosurgery, in which a new vegetable (*Ricinus communis*) derived polymer was used in two different forms: hard dural graft (plaque) and soft material (gum) that rapidly acquire a hard consistence.

Results: Vegetable polymer was used for skull base reconstruction in seven cases. Four cases of meningiomas, two cases of large basal meningoceles, and one case of non-secreting pituitary adenoma. The dural graft was used alone in two cases. The moldable gum was used alone in three cases, and in the remaining two cases both presentations were used. Postoperative CSF leak occurred in the two cases that the dural graft was used alone. When the moldable gum was used, no CSF leak was observed.

Conclusions: This new vegetable derived polymer has been useful for reconstruction of large skull base defects. It is another option for the skull base team armamentarium. Further studies are needed in order to determine its efficacy.

Frameless face-mask based navigation during endoscopic transphenoidal skull base surgery. Technique and results

V.I. Vougioukas, M. Shah (Freiburg, Germany)

Introduction: Recent advances in endoscopic skull base surgery aim to minimize intra and postoperative morbidity. Nevertheless resection of extended skull base tumours remains a surgical challenge. Aim of this study was to evaluate feasibility and efficacy of a newly developed navigation technique based on a commercially available face-mask during endoscopic transphenoidal skull base procedures.

Materials and Methods: Face-mask based frameless navigated endoscopic transphenoidal surgery was performed in 21 patients with recurrent pituitary adenomas, 4 patients with clivus chordomas and 2 patients with a meningioma. In all cases a preoperative radiological work-up including MRI, CT and CT-angiography was conducted.

Results: Automatic patient registration was achieved in all cases in 30 seconds. Intraoperative accuracy of the navigation system ranged between 1–2 mm. There was no additional morbidity associated with the navigation system. The registration mask allowed real time patient tracking while the patients head remained mobile.

Conclusion: Face-Mask based navigated endoscopic-transphenoidal skull base surgery is an effective and reliable alternative to conventional navigation techniques. It should be noted that the described technique alleviates the need for perioperative fluoroscopic images. Overall, the technique facilitated the approach to the region of interest and enabled fast and accurate identification of anatomical landmarks.

Extended endoscopic endonasal transphenoidal approach for skull base lesion: availability of multilayered reconstruction method

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Aim: Endoscopic surgery is suitable for transphenoidal approach as it can be performed by bright vision and minimum invasiveness. Using bilateral nostril approach, extended trans-

phenoidal surgery (E-ETSS) is able to be applied easily. We examined the availability and issue of E-ETSS based on our experiences.

Materials and methods: Between 2004 and 2008, total 15 procedures of E-ETSS were performed in our institute. They included 8 meningiomas, 2 pituitary adenomas, 2 Rathke's cleft cysts, 2 chordomas and 1 craniopharyngioma. Operation was performed through bilateral nostrils using rigid endoscope with preparing wide mucosal flap from one septal mucosa bone window was enlarged anteriorly to planum sphenoidale, laterally to expose the cavernous sinus and inferiorly to expose basilar artery depending on the lesion. Reconstruction of skull base after removal of the tumours were performed by multilayered method with polyglactin acid (PGA) sheet and mucosal flap.

Results: Gross total removal was achieved in all meningiomas, pituitary adenomas, and craniopharyngioma in the 11 frontal base lesions. Intracavernous extension of meningiomas and chordomas were partially removed. No cranial nerve injuries and visual disturbance were observed after surgery. CSF leakage was observed in one patient who was required surgical repair. Spinal drainage was performed in 10 of 11 frontal base lesions and continued for 5.2 days in average. Excellent mucosal adhesion was observed within 3 months after the operation when we examined endoscopically.

Conclusion: Extended endoscopic approach thorough bilateral nostrils and multilayered reconstruction of skull base with mucosal flap and PGA-sheet are safe and effective procedure for various parasellar lesions.

The endonasal endoscopic transpterygoidal approach: indications and techniques in endoscopic endonasal surgery

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Introduction: Pterygo-palatine fossa is a small pyramidal area located deeply in the skull base. We use this approach for lesions involving the lateral wall of cavernous sinus, the lateral recess of sphenoidal sinus and middle cranial fossa.

Materials: In the last decade we performed 68 endonasal transpterygoid approaches: 7 pituitary adenomas over 353 fully endonasal endoscopic pituitary adenoma's resections, 2 cases of craniopharyngiomas, 15 Stenberg's CSF fistulae, 35 juvenile angiofibromas, 1 chordoma and 8 miscellaneous lesions.

Results: In all cases we reached the complete control of the margins of the lesion, and satisfactory exposure of the lateral wall of cavernous sinus.

Conclusions: We describe anatomical boundaries, surgical steps and applications of our technique. This extended approach allows a better control of the lateral surgical spaces of the anterior and middle fossa in fully endoscopic endonasal procedures.

Skull base endoscopic endonasal approaches: experience of 50 serial cases

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Introduction: Endoscopic endonasal approaches to skull base represent a natural evolution of neurosurgery. Progressive development of endoscopic techniques has allowed safe resection of skull base tumours avoiding large conventional craniotomies.

There is still controversy regarding the indications for endonasal surgery, its limits and complications.

Material and Method: Retrospective study of 50 cases submitted to endoscopic endonasal skull base approaches in “Santa Casa de Sao Paulo” from February 2005 to December 2008.

Results: There were 21 men and 29 women between 17 and 65 year old. Thirty six patients had pituitary tumours, two had Rathke’s cleft cysts, two had craniopharyngiomas and were submitted to transphenoidal transellar approaches (80%). One patient with adenoma infiltration of cavernous sinus was operated through a transcavernous sinus approach (2%). Four patients with tuberculum sellae meningiomas were operated through transtuberculum/transplanum approaches (8%). One patient with olfactory groove meningioma, one patient with solitary fibrous tumor and one with ethmoidal osteoma were submitted to transcribiform approaches (6%). Three patients were operated through transclival approaches (6%): two chondrosarcomas and one inflammatory osteogenic lesion. Complete resection was achieved in 14 adenomas, 2 Rathke’s cleft cysts, 1 craniopharyngioma, 2 meningiomas (one olfactory groove and one tuberculum sellae), 1 osteoma, 1 fibrous solitary tumour, 1 chondrosarcoma. There were 12 (24%) cerebrospinal fluid fistulas, 9 were treated with lumbar drainage, 2 developed hydrocephalus and required ventriculoperitoneal shunt, 1 patient required reoperation. One patient (2%) with a clival lesion had an intraoperative carotid lesion that was treated with endovascular therapy. Four patients (8%) developed meningitis. One patient (2%) with giant tuberculum sellae meningioma died of pyogenic ventriculitis.

Conclusions: The results of endoscopic endonasal approaches to skull base vary according to topography of lesions and require a learning curve. The transphenoidal transellar and the transcribiform approaches are in our experience safe, effective and have low morbidity. The transtuberculum/transplanum and transclival approaches carry a higher morbidity especially for giant tumors.

The transmaxillary approach to contralateral cavernous sinus

L.F. Alencastro, L.C. Alencastro, C. Martins, A.C. Capel, S. Osawa, K. Inoue, M. Faria, A.L. Rhoton Jr. (Porto Alegre, Brazil; Recife, Brazil; Florida, USA)

Introduction: Several surgical techniques, including a number of neuroendoscopic procedures, have been described to the approach of sellar and parasellar lesions. The authors present the concept of radial endoscopic approaches to the skull base, focusing in this paper on the transmaxillary route to contralateral cavernous sinus. Other endoscopic approaches compose the radial endoscopic approaches to skull base.

Objective: Describe the transmaxillary route to contralateral cavernous sinus, demonstrating the potential advantages and pitfalls of the approach.

Material and Methods: Eight silicone-injected cadaveric heads were used in this study. The transmaxillary endoscopic approach was performed and images captured using 0 and 30 degree endoscopes (Karl Storz, Germany). An axial cut was performed to show the trajectory of approach. Landmarks are highlighted and measurements taken to characterize the approach and establish comparison with the conventional endonasal route.

Results: The approach starts sublabially by incising the mucosa and anterior wall of the maxillary sinus. The medial wall of the

maxilla is visualized and trespassed, removing the posterior third of the middle turbinate. This manoeuvre exposes the sphenoid rostrum on the side of the approach. Expanded exposure of the sphenoid rostrum is obtained by detachment or resection of the posterior nasal septum. Once the sphenoid sinus is reached removal of intersinus septum is undertaken, in order to expose the lateral wall of the sinus on the opposite side of the approach. An oblique approach to the medial wall of the cavernous sinus is obtained offering a optimized pathway to cavernous sinus dissection of lesions extending lateral from the sella. The contralateral paramedial clivus was also accessible through this approach. The distance from the anterior wall of the maxillary sinus to the anterior bend of the contralateral carotid artery was on average 74 mm (range: 71 to 79 mm). The distance from the anterior nasal spine to the anterior carotid bend was on average 83 mm (range: 77 to 88 mm). The most favourable angle for the transmaxillary trajectory to the contralateral cavernous sinus was 44 degrees on average.

Conclusion: The transmaxillary approach to the contralateral cavernous sinus is potentially useful as the only route or in combination with the classic transnasal approach for the treatment of sellar, cavernous sinus and clival pathology. Exposure of the medial wall of the contralateral cavernous sinus was accomplished through a shorter trajectory and a more favourable working angle. This data suggests that conventional microsurgical and endoscopic instruments are suitable for this procedure. The transmaxillary approach provided exposure of the clivus postero-medial to the vertical segment of the petrous carotid artery, allowing control of the transdural segment of the contralateral VI nerve and access to structures into the prepontine and medial portion of the contralateral cerebellopontine cistern. This study suggests that the transmaxillary approach should be considered in case of pathology of sella, parasellar and clival regions.

The infratemporal endoscopic approach to cavernous sinus, clivus and petrous apex

L.F. Alencastro, L.C. Alencastro, C. Martins, A.C. Capel, S. Osawa, K. Inoue, M. Faria, A.L. Rhoton Jr. (Porto Alegre, Brazil; Recife, Brazil; Florida, USA)

Introduction: There is a variety of microsurgical approaches to the skull base. Great development of neuroendoscopic techniques have been made into this area. The authors present the concept of radial endoscopic approaches to the skull base, focusing in this paper on the endoscopic assisted infratemporal approach to cavernous sinus, clivus and petrous apex. Other endoscopic approaches compose the radial endoscopic approaches to skull base.

Objective: Describe the endoscopic assisted infratemporal route to cavernous sinuses, clivus and petrous apex demonstrating the potential advantages and pitfalls of the approach.

Material and Methods: Eight silicone-injected cadaveric heads were used in this study. The endoscopic assisted infratemporal approach was performed and images captured using 0 and 30 degree endoscopes (Karl Storz, Germany). An axial cut was performed to show the trajectory of approach. Anatomical landmarks useful for this procedure were highlighted.

Results: The endoscopic assisted infratemporal approach involves a middle fossa craniotomy, just above the zygomatic arch. Partial

resection of the zygomatic arch can also be undertaken. The trajectory of approach can be tailored through the anterior petrosal surface and to the medial portion of the middle fossa. Drilling the floor of the middle fossa may avoid temporal lobe retraction when aiming to the ipsi and contralateral cavernous sinus region. The endoscope is brought to the field for better visualization and lightening of deep structures. If the trajectory is towards the petrous apex, endoscope visualization is especially helpful for drilling under the trigeminal ganglion and lateral clivus. Endoscope assistance can also improve visualization around foramen ovale and rotundum, as for dissecting along the lateral surface of the cavernous sinus. Entrance to the lateral recess of the sphenoid sinus can be undertaken, potentially allowing for dissection into the contralateral cavernous sinus.

Conclusion: The endoscope may be helpful during particular stages of middle fossa approaches, especially when working along deep seated structures. The magnification and lightning of the endoscope may turn drilling in the area of foramen rotundum and ovale a gentler and safer procedure. Careful displacement of second and third divisions of trigeminal nerve creates a corridor for reaching the lateral portion of sphenoid sinus. Pending on the degree of sinus pneumatization and drilling of the superolateral wall of the lateral recess of sphenoid sinus, this manoeuvre may allow reaching the contralateral cavernous sinus in a perpendicular access. This study demonstrates that the endoscope has a potential role in assisting the infratemporal approach to the petrous apex, clivus, and cavernous sinuses. The use of the endoscope in the setting of a central skull base pathology may increase the safety of the procedure and deserves further study.

Vascularised pedicled flap of posterior nasoseptal mucoperiosteum and mucoperichondrium in endoscopic endonasal surgery for midline skull base lesions: early experience and short term outcome

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Introduction: One of the major advantages of vascularised pedicled flap of the posterior nasoseptal mucoperiosteum and mucoperichondrium is to promote healing following reconstruction for large sellar defect. We are routinely using this novel technique as an adjunct to on-lay multilayer reconstruction for sellar defect with intraoperative CSF leakage following endoscopic removal of intrasellar lesions with suprasellar and intraventricular extension as a combined effort between Neurosurgeon and Otorhinolaryngologist.

Methods: From 2006 to 2008, a total number of 20 patients underwent endoscopic endonasal surgery for various midline skull base lesions by the authors at Department of Neurosurgery, Hospital Kuala Lumpur, Malaysia. Vascularised pedicled flap of posterior nasoseptal mucoperiosteum and mucoperichondrium based on posterior nasoseptal-sphenopalatine artery were performed in 7 cases as adjunct to on-lay multilayer reconstruction for intraoperative CSF leaks and large sellar defect. These include Craniopharyngioma (2), Suprasellar Meningioma (3), Nonfunctioning Pituitary Macroadenoma with intraventricular extension (1) and suprasellar arachnoid cyst (1). Endoscopic examination of nasal cavity were performed preoperatively by the rhinologist to exclude associated intranasal pathology and nasal decongestion were given as a routine. The posterior nasoseptal flap was mobilized first at the

initial nasal phase. Following removal of the interest pathology, multilayer on-lay reconstruction was performed using combination of fascia lata, subcutaneous fat, surgical and Tisseel glue. The flap was then mobilized to cover the first construction and hold in place with Tisseel glue. Temporary external lumbar drain was inserted in 5 cases. Follow-up endoscopic examination of the flap reconstruction was conducted by the rhinologist at 2 and 6 weeks after surgery to assess the viability and patency of the flap.

Results: The flaps survived and were viable in all cases (100%), there was no clinically detectable postoperative CSF leakage in all patients. There was no mortality related to the procedure but one patient developed gram negative ventriculitis with right maxillary sinusitis as a complication of flap retraction which later underwent flap revision.

Conclusion: Vascularised pedicled flap of posterior nasoseptal mucoperiosteum and mucoperichondrium offers extra advantages as it promotes healing and provides additional support in endoscopic endonasal reconstruction for sellar defect.

Extended endoscopic transphenoidal surgery for tuberculum sellae meningiomas

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Introduction: Tuberculum sellae meningiomas account for 5 to 10% of all intracranial meningiomas and are conventionally removed through different surgical transcranial approaches including bifrontal or unifrontal, pterional or frontolateral approaches with the use of the microscopic techniques. Surrounding important neurovascular structures is one of the difficulties in the surgical treatment of these tumours. The extensive use of the endoscope in transphenoidal pituitary surgery has recently offered to the extension of the approach through the tuberculum sellae with an endoscope-assisted or purely endoscopic technique. CSF fistula is one of the most often seen complication in extended approaches.

Material and Method: 230 pure endoscopic endonasal transphenoidal operations were performed between September 1997 and December 2008 in Kocaeli University, Department of Neurosurgery. We described endoscopic transphenoidal approaches from a retrospective analysis of 6 patients with TSMs (Grade I: 2 patients, Grade II: 3 patients and Grade III: 1 patient considering Yasargil's classification) for the last two years.

Results: Total removal was achieved in 4 patients and subtotal removal was performed in 2 patients. An improvement of the preoperative visual deficits was observed in three of the six. One patient had total visual defect preoperative. No permanent visual worsening was observed in all patients. Length of postoperative hospital stay varied from 6 to 8 days. After positioning free fascia lata graft, multilayer technique was used for the closure. CSF leakage or any other complication was not seen in any of the patients.

Conclusion: This approach avoids brain retraction, minimizes optic apparatus manipulation, and permits working under direct visual control to realize a Simpson Grade 1 removal, which is defined as complete tumour removal with excision of the lesion dural attachment and involved bone. Total removal of higher grade lesions can be achieved by improving surgical techniques and experience.

Extended endoscopic endonasal removal of cranial base meningiomas

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The extended endoscopic endonasal approach is an innovative method of exposure of the midline cranial base and its recent indications have included lesions located in the supra- and parasellar areas, such as cranial base meningiomas. During a 4-year time-frame we used the extended endoscopic endonasal technique for the resection of 21 cases of cranial base meningiomas (9 tuberculum sellae, 4 olfactory groove, 2 planum, 3 cavernous sinus, 1 diaphragma, 1 pterygo-palatine fossa and 1 retroclival meningiomas), which were carefully selected on the basis of the preoperative imaging studies. We obtained a gross total removal of the lesion in 8 tuberculum sellae and 6 olfactory groove/planum meningiomas, while only a subtotal or partial excision was possible for cavernous sinus and retroclival masses, respectively. The surgical mortality occurred in one case of TSM, not directly related to the surgical procedure, while the morbidity was low and mainly regarded postoperative CSF leakage (14.3%), requiring reoperation for repair. No cases of permanent postoperative worsening of the visual function occurred. No new postoperative endocrinopathies were observed. This approach obviates brain retraction, minimizes neurovascular manipulation, and permits working under direct visual control. The reconstruction of the osteodural defect can be particularly troublesome given the relatively big cranial base defect, especially in meningiomas with large dural attachments, where an extensive bone removal and dural coagulation and opening is required. This approach allows starting the lesion removal from its attachment but is certainly not suitable for all midline skull base lesions. Patients should be carefully examined to define the appropriate indications for a transphenoidal route. Once the technological advancement in instrumentation, either optical or surgical, improves, the present limitations may decrease and thus make such a technique safer and more feasible for experienced surgeons. We think that as case volume increases, the indications for this approach may be additionally extended, thereby rendering it a viable alternative to the microscopic transcranial approaches.

Extended endoscopic endonasal approach to skull base

O. Lopez Arbolay, J. Gonzalez Gonzalez (La Habana City, Cuba)

Introduction: Different approaches to the skull base have been developed through the sphenoidal sinus. Traditional boundaries of the transphenoidal approach can be extended in antero-posterior and lateral planes. We review our experience with the extended endoscopic endonasal approach in our first 30 cases.

Methods: We used the Extended Endoscopic Endonasal Approach in 30 patients with different lesions of the skull base. This study specifically focuses on types of lesions, surgical approach, outcome and surgical complications.

Results: The extended endoscopic endonasal approach was used in 30 patients with following lesions: 11 invasive adenomas to cavernous sinus, 4 clival chordomas, 4 craniopharyngiomas, 1 hypothalamic astrocytoma and 10 pituitary adenomas extending into the tuberculum sellae. Gross total resection was achieved in 21 cases (70%) subtotal resection in 8 (26,7%) and biopsy only could be accomplished in the case with the astrocytoma. This

patient developed meningo-encephalitis and died two weeks later.

Conclusions: The extended endoscopic endonasal approach is a promising minimally invasive alternative for selected cases with sellar, parasellar or clivus lesions. As techniques and technology advance this approach should be considered an option by skull base surgeons and may become the procedure of choice in the management of the patients with these complex pathologies.

Endoscopic transphenoidal surgery of chordoma

Y. Zhang, Z.-c. Wang, De-an Zhao, Y. Zhou, Z. Shiyuan, X. Zong, M. Song, Ao Pei, P. Zhao (Beijing, China)

Objective: To investigate the techniques, methods, indication and therapy of endoscopic transnasal transphenoidal surgery for chordoma. **Clinical Materials and Methods:** 30 patients with chordoma were treated by endoscopic transphenoidal surgery between June 2000 and June 2006. 29 patients with chordoma were operated through a transnasal transphenoid approach between the nasal septum and middle nasal concha, firstly to remove related bony structure with a high-speed drill in order to expose the chordoma and then to divide into small pieces of resection by the hard neuroendoscopy with 30° and 70° angle. In 1 case craniotomy was performed to dissect the parts of tumour in the skull under the microneurosurgery, then to resect the other parts of tumour situated at clivus, sellar area and maxillary sinus as well as infratemporal fossa under the orientation of neuroendoscopy. 18 cases were followed-up 10–18 months after operation.

Results: Almost total resection was obtained in 7 cases; subtotal resection in 16 cases, partial resection in 7 cases. Clinical symptomatic improvement of 24 cases was best achieved after operation. In 6 cases there was no change. All patients recovered their daily life one week after operation. 1 case with leakage of cerebrospinal fluid occurred and operative repair was performed. 4 cases with the characteristic tumours of extensive growth had a relapse 10–18 months after operation.

Conclusion: Endoscopic transphenoidal surgery of chordoma has some obvious advantages such as safety, efficiency, simple manipulation, very good visualisation of operative field, absence of serious complications, patient's quick recovery and short hospital stay. The indications used for this method were for tumours situated at middle-upper clivus and sellar area and tumour main body located at the midline of the base of skull. It was very important that surgical indication is carefully selected.

Improvement of suction elevator for endoscopic endonasal transphenoidal surgery: technical note

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Background: There are mainly two approaches to sphenoid sinus, one is a midline nasal septum approach and the other is a direct sphenoid sinus approach. The midline approach has a merit of wider view and working spaces bilaterally preserving nasal mucosa of the anterior wall of sphenoid sinus. However, bleeding sometimes disturbs the approach. In order to solve this problem, we have improved a suction elevator used in ENT (ear-nose-throat) surgery for endonasal transphenoidal surgery (ETSS).

Instrument: The suction elevator used in ENT surgery has a sharp and hard tip for cutting and dissecting mucosa with a hole for

suction. There is a hole in the body of the instrument for the control of suction. The end is connected to aspiration tube. However, since the distance between the tip and the hole for the control of suction is too short, it is not suitable for ETSS. The connected aspiration tube sometimes disturbed the free movement of the elevator. We have modified the position of the hole in the body at hand. We have also changed the end of the instrument rotating freely.

Result: The improvements make it possible to reach the sphenoid sinus, and change the direction of the tip as we like easily. Using this instrument, we can hold an endoscope in one hand, and perform cutting, dissecting, and suction simultaneously in the other hand. This can save time to approach to the sphenoid sinus. There is no complication due to this instrument.

Conclusion: The use of an improved suction elevator is recommended for the approach to sphenoid sinus of the midline nasal septum approach.

Endoscopic skull base surgery using a novel three-dimensional system

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Objective: The endoscopic approach to the skull base is a well established method for removal of skull base tumors and for reconstruction of cranial basal defects. However, the main drawback of conventional endoscopes is their 2-dimensional view, which limits depth of perception and hence the surgeon's ability to detect anatomical structures at the skull base. Our goal was to evaluate the utility of a novel three-dimensional (3D) endoscopic system for excision of skull base tumors.

Methods and patients: Of 25 cases operated via the 3D endoscopic approach (3DEA), 4 (16%) were for excision of malignant tumors and 20 (80%) for benign lesions. In one patient the 3DEA was used for skull base reconstruction. Six patients (24%) underwent previous surgery. Tumors involved the anterior skull base (n=6), sphenoid and planum (n=19), clivus (n=4), sella (n=9) and cervical spine (n=1) regions. Reconstruction was performed with nasal septal flap, bone flap or fascia lata for defects with high flow leak (n=8) and with fat for low flow leaks (n=7).

Results: Complete tumor resection was accomplished in all cases. One patient had perioperative complication which included gram-negative meningitis (4%). There were no postoperative cerebrospinal fluid (CSF) leaks, pneumocephalus, intracranial bleeding or mortality. We evaluated the surgeons' ability to promptly recognize anatomical structures at the skull base using 0° and 30° 3D and conventional endoscopes. The 3DEA technique was superior to the conventional technique for identification of the sellar region, carotid prominence, optic prominence, cribriform plate and fovea ethmoidalis ($P < 0.05$), but not for detection of the turbinates, clivus, sphenoid, maxillary, ethmoidal and frontal sinuses.

Conclusion: 3D endoscopic skull base surgery is feasible for resection of tumors and reconstruction. Stereoscopic view via endoscopes allows easier recognition of anatomical landmarks at the skull base, but do not offer significant advantage in the paranasal sinuses and nasal cavity.

Pitfalls and rare indications for cranial endoscopy

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Introduction: Endoscopy became an important tool for treatment of some common diseases as hydrocephalus. Overcoming management difficulties and registration of new indications are worth of comments. Based on a limited experience, the authors studied their indications explaining the main pitfalls of endoscopic treatment as well as use of this technique for rare diseases as cranial malformation.

Material and methods: A cohort of 53 patients submitted to cranial endoscopy at Hospital Santa Isabel, Universidade Regional de Blumenau, is presented.

Results: Forty were third ventriculostomies for hydrocephalus, 6 cysticercotic cysts, 6 intraventricular colloid cysts and 1 anterior basal meningocele. Three patients needed shunt after 3rd ventriculostomy, 1 had subdural hygroma and three had bleeding which demanded temporary external drainage. Characteristics of intraventricular colloid cysts are depicted showing some pitfalls and description in some detail of the anterior cranial meningocele case completes this report.

Conclusions: Pitfalls and advantages of starting endoscopy after a long experience with general neurosurgery may help other surgeons to accelerate the learning curve.

Application of endoscopes in minimally invasive neurosurgery

C-C. Shen, W-Y. Cheng, S-D. Lee, M-Y Yang (Taipei, Taiwan)

Introduction: The use of endoscopes in neurosurgery has made an unexpected progress during recent years. Advanced endoscopes have simultaneously stimulated the development and application of minimally invasive treatment concepts in many neurosurgical fields. Now they are considered as a well-established operative technique in skull base surgery. We will present our experiences of the application of endoscope in the skull base surgery.

Materials and Methods: Various rigid and/or flexible endoscopes were used according to the indication and the planned operative approach. Neuroendoscopic interventions were applied for therapeutic interventions for more than 1000 skull base surgeries. Special monitor, instruments and Navigator were applied in some situations.

Results: From 1997 to 2008, we have successfully performed more than 1000 endoscopic or endoscopy assisted microneurosurgical interventions, including 850 pituitary tumors, 30 skull base lesions, 30 acoustic neuromas, 20 intracranial aneurysms, 20 intracranial arachnoid cysts, 40 neurovascular compression syndromes, 50 hydrocephalus. No mortality was found. The morbidity rate is below 1%

Conclusions: Neurosurgery has become an essential part of minimally invasive neurosurgery in skull base surgery. We feel that this technique will be more acceptable to treat a vast majority of skull base lesions with low morbidity and short hospital stay.

Prevention of CSF leakage after endoscopic third ventriculostomy (ETV)

D.A. Karabetsos, N.A. Chochlithakis, A.F. Vakis (Heraklion, Greece)

Background: Postoperative CSF leakage is a common complication of neuroendoscopic procedures. Particularly in ETV cases

CSF leakage is also considered a factor of ventriculostomy malfunction. Several methods have been developed (glue sealants, dural sutures, haemostatic sponges) in order to prevent the leak of CSF through the course of the endoscope and mostly through the craniotomy burr hole.

Patients, Methods and Results: We present 32 patients (19 female [59.4%], 13 male [40.6%], mean age 57.4 y.) who underwent ETV, in our department, for the treatment of obstructive hydrocephalus during the last four years (2005–2008). In 10 of these patients no additional technique was applied for the closure of burr hole or the sealant of the intraparenchymal path of the endoscope. The operation closure was simply performed by suturing the galea and the skin over the burr hole. In 3 of these patients subcutaneous CSF collection was observed in the burr hole site between the 3rd and the 6th postoperative day. In one patient CSF leakage from the skin wound was observed immediately postoperatively, accompanied by ventriculostomy failure resulting to reoperation, shunt placement and resuturing of the wound. In the rest 22 cases, human bone graft chips (TBF France) from live donor were used for the closure of the burr hole. The chips were mixed with human demineralised bone matrix (sure fuse -putty) and patient's blood. The mixture was applied to the burr hole and finally the galea and the skin was sutured. No CSF leak or CSF collection was observed in any of the 22 patients.

Conclusions: 1. CSF leakage is considered a serious complication of ETV but it is not clear if it is the actual cause or just a result of ventriculostomy malfunction. 2. Our observations suggest that there is no need for extreme closure techniques (intraparenchymal fibrin glue, dural suturing, etc.) in order to prevent CSF leakage after an ETV operation. 3. The use of bone graft chips together with blood and bone matrix is a safe method for closing ETV burr holes, efficient enough for CSF leak prevention.

Technology and Instrumentation

Initial experience with a new multipurpose ventriculoscope

H.W.S. Schroeder (Greifswald, Germany)

Objective: To describe the initial experience with a new multipurpose ventriculoscope.

Material and Method: The endoscopic system includes an endoscope, an endoscopic sheath, and a trocar. The outer diameter of the sheath is 6.8 mm. The working length is 14 cm. The endoscope has an outer diameter of 6.0 mm. It contains a 2.7 mm rod lens, light fibers, a 2.9 mm main working channel, and two 1.6 mm side channels. The ventriculoscope combines the advantages of several neuroendoscopic systems which are already available and provides some new features.

Results: To date, 36 procedures including 14 ETV, five septostomies, four tumour biopsies, four aqueductal stentings, three colloid cyst extirpations, two aqueductoplasties, one foraminoplasty, two ventriculocystostomies, and one ventriculocystocisternostomy have been performed with the ventriculoscope. The age of the patients ranged from 6 months to 72 years. All procedures were successfully completed. No procedure had to be abandoned because of technical problems. There was no mortality. One salt

wasting syndrome occurred after ETV in a 1.5-year-old girl, but resolved spontaneously.

Conclusion: The ventriculoscope is a universal neuroendoscopic system with which all endoscopic intraventricular procedures can be performed in most of the patients. Because of its diameter, it is not designed for the endoscopic treatment of newborns.

Value of High Definition (HD) imaging in neuroendoscopy

H.W.S. Schroeder, M. Nehlsen (Greifswald, Germany)

Objective: To compare the image quality of a standard SD 3-chip-camera with a new HD 3-chip-camera.

Methods: In five surgeries, a SD 3-chip-camera and a HD 3-chip-camera were used with the same endoscopic equipment. Both cameras were used while performing one ventricular endoscopy (third ventriculostomy in occlusive hydrocephalus), one endoscope-assisted microvascular decompression, one endoscope-assisted removal of a vestibular schwannoma, and two endonasal pituitary surgeries. To provide comparable conditions, the output of both cameras was displayed on the same flat screen (1920 x 1080p) and was recorded on a hard disk. The work station contained an AJA Xena LHe Capture Card, the Adobe CS 3 Production Suite and the Cineform Codec, which is visually lossless and amongst the most advanced compression algorithms available. The compression factor was approximately 1:10 in both cases. Both cameras were used with full light intensity and maximal zoom. The cameras were connected to the same rod-lens endoscopes (2.7, 2.0, and 1.7 mm lens) one after the other.

Results: The image quality of HD was far superior in all applications. Especially in pituitary surgery, the difference was striking when the tumour had to be differentiated from the normal pituitary tissue. Improved resolution and colour vibrance explained the better images in HD. Because of the 16:9 aspect ratio, the viewing field of the HD camera was wider compared to the 4:3 aspect ratio of the SD camera. The progressive image processing of the HD camera along with the higher resolution provided a much clearer image than the image of the SD camera, which is partially due to the higher resolution of the HD camera and partially due to interlaced image processing of the SD camera. Interlaced image processing in itself is far inferior to progressive image processing when viewed on a flat panel screen.

Conclusion: Since HD provides a much better image quality and resolution, HD cameras should be used in neuroendoscopy whenever a superb image quality is required.

A new navigation guided expandable brain cannula for neuroendoscopy

V. Waran, N. Vairavan, N.F.A. Bahuri, D. Ganesan, B.J.J. Abdullah (Kuala Lumpur, Malaysia)

Introduction: The authors describe a newly developed expandable cannula to enable a more efficient use of an endoscope. This paper covers the initial work with the cannula in removing intraparenchymal haematomas secondary to hypertension. The cannula is introduced like a conventional brain cannula using neuronavigation techniques to ensure safe and effective trajectory to reach the targeted lesion. Once in position it is expanded creating a single large channel to introduce both endoscope and surgical tools.

Methodology: This method was prospectively used in 6 consecutive patients between March and December 2007 with hypertensive intra-parenchymal haematomas requiring surgery. The patients had an admitting GCS of 6–13. In all patients intra-operative ICP monitoring was carried out to address safety concerns and all patients had both pre and post operative CT scans to assess adequacy of haematoma evacuation.

Results: In all six patients we were able to reduce the size of haematoma in all as confirmed by both intra-operative ICP monitoring and post operative CT scans. There were no surgically related mortalities or increased morbidity as the result of the direct use of the cannula. The coupling of microsurgical techniques together with the endoscope improved the ergonomics of the operations.

Discussion: The expandable cannula that we have developed has enabled us to more efficiently operate within the parenchyma of the brain using an endoscope. The two main advantages of this method was that we were able to decouple the movements of the instruments from that of the endoscope and the larger single channel created allowed us to use larger conventional micro-instruments leading to an operation that was ergonomically more efficient. The expanded cannula gave a 360° protection to the brain parenchyma from the passing instruments and rod lens. The use of navigation techniques ensured safe and effective trajectory to our target. We will be describing this new technique that we have developed and discuss our results.

A new expandable brain cannula for the treatment of intracranial pathologies using endoscopes

V. Waran, N. Vairavan, N.F.A. Bahuri, D. Ganesan, B.J.J. Abdullah (Kuala Lumpur, Malaysia)

Introduction: The authors describe a newly developed expandable cannula to enable a more efficient use of an endoscope for surgery within the brain parenchyma and the ventricular system. Surgery on the brain using current neuro-endoscopic techniques is limited as all instruments and the rod lens have to pass along parallel tubes. This makes the operation both clumsy as all instruments have to move in tandem with the rod lens and tedious as no instrument of significant size can be used for efficient surgery.

Methodology: The new expandable brain cannula was used in a consecutive series of patients with various pathologies since January 2008. We initially used it patients who would have been offered conventional endoscopy and later extended to other intra-parenchymal pathologies as well. All patient data was documented prospectively and where necessary post operative imaging was carried out to confirm the adequacy of the operation done.

Results: This is an ongoing study started in March 2007. At the point of this abstract a total of 15 patients have undergone this form of endoscopy. Beginning with patients with hypertensive haemorrhages (7 patients) we have used this technique successfully in excising colloid cysts (3 patients), decompression of other forms of cysts (2 patients) and Biopsy of brain tumours (4 patients). We were able to achieve our set targets in all 16 patients with no surgical related mortalities. One patient with a colloid cyst suffered from transient memory impairment that fully recovered.

Discussion: The expandable cannula that we have developed has enabled us to more efficiently operate within the parenchyma of

the brain using an endoscope as we have succeeded in uncoupling the movements of the operating instruments from that of the rod lens. The second advantage was that we were able to use conventional micro-instruments via the expanded cannula and this made the operating technique more efficient.

Electromagnetic neuronavigation-guided endoscopic biopsies of pediatric brain tumours

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Background: Reliable histological diagnosis is crucial for optimal planning of therapeutic strategy, particularly in the case of deep-seated or multiple CNS lesions, where open surgical approach is not the first option. Endoscopic biopsy is a generally accepted technique in this setting, particularly in the case of tumours adjacent to cerebral ventricles. The aim of this study was to assess effectiveness of neuronavigation-guided endoscopic biopsies of brain tumours in children and its impact on histological diagnoses thus obtained.

Material and method: From 1996 to 2008, at the Department of Neurosurgery, Children's Memorial Health Institute, Warsaw, Poland, 144 neuroendoscopic biopsies of brain tumours in children were performed. Pathological diagnoses were obtained in 115 out of 144 patients (79,9%). In 51 out of 55 cases (92,7%) the diagnosis was confirmed by open biopsy in patients who subsequently underwent microsurgical tumour resection. Implementation of electromagnetic neuronavigation-guided endoscopies in 32 cases significantly ($p=0.026$) improved efficacy of the procedures with only 2 diagnostic failures. In the pre-neuronavigation era, among various tumour locations encountered (lateral ventricles, suprasellar, posterior cranial fossa, posterior part of the third ventricle, thalamus, and disseminated intraventricular tumours), endoscopic biopsies of thalamic tumours proved significantly less effective ($p=0.001$): only 13 out of 26 thalamic tumour biopsies (50%) yielded a reliable pathological diagnosis. On the other hand, 9 out of 10 neuronavigation-assisted endoscopic biopsies proved effective ($p=0.00126$).

Conclusion: Electromagnetic neuronavigation-assisted neuroendoscopy is an effective and reliable tool providing tissue samples for pathological verification in children with intra- and periventricular tumours, improving effectiveness of the procedure especially in the case of thalamic lesions.

Safety in endo-neurosurgery: parameters of ergonomics in Neuroendoscopy

K.D.M. Resch, Ch.B. Lumenta (Muenchen, Germany)

Introduction: In major international studies on patients safety unexpected events are correlated mostly with operative procedures (up to 45,4%, Davis et al NZ Med J 116 2003). A neglected promoter of this results seem to be correlated with bad working setting, like in neuro-endoscopy. This paper draws attention to some principles of ergonomics for neuro-endoscopy with the focus on endoscopy assisted microneurosurgery.

Materials and Methods: Preclinical laboratory work during many years showed evidence to study ergonomics of neuro-endoscopy in a para-endoscopic operation simulation setting. Para-endoscopic preparations through key-holes were performed in more than 200 non-fixed specimens using modern

microsurgical and endoscopic techniques at the dissection table. Ergonomics of the setting was focussed and examined according to spatial, procedural and mental criteria and were described and documented. A concept of ergonomics for endoneurosurgery was derived from this laboratory work and clinical experience and worked out inductively into three paradigms.

Results: 1) Spatial Ergonomics: It is describing the operative environment by means of Gestalt-theory: i. The operative environment has a meaningful structure of virtual emergent orbits. ii. Each orbit has a different ergonomic sensitivity iii. The higher the ergonomic sensitivity is, the more a failure will affect the procedure. 2) Procedural Ergonomics: The operative procedure is a chaotic system. This means description of the operation by fuzzy logic. i. A chaotic system shows exact defined parameters, but its outcome is never predictable ii. A chaotic system can only be influenced by its peripheral parameters The peripheral parameters of an operation are (for example): Equipment and Design (technique), Physical Fitness of the Surgeon (body), Mental Fitness of the Surgeon (mind), Work flow of the Team (interpersonal interaction) 3) Mental Ergonomics: Each surgical procedure on a patient's brain takes place before in the surgeon's brain. This is a description of the operative procedure by means of neuro-psychology. The surgeon's efficacy and manual abilities are seen as a result of an action in the surgeon's brain: i. The surgeon's brain is the main surgical instrument. ii. The endoscopic setting must be designed according to neuropsychology iii. The endoneurosurgical training is not only technical but also a mental task.

Conclusion: Realisation of neuroendoscopy according to principles of ergonomics is a matter of safety for the patient. Ergonomics for neuroendoscopy need to come into the focus of neurosurgeons.

A novel design for steerable endoscopic instruments

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Introduction: The simultaneous use of two instruments through one endoscopic shaft remains difficult. The parallelism of the instruments at the tip renders the interaction between them cumbersome. Instruments with a bendable or steerable tip are the solution. It is, however, very challenging to manufacture steerable instruments of such a small diameter. State-of-the-art technology uses pulling wires fed through guiding sleeves. The production of these instruments is expensive, and the instrument tips are not very robust, their bending not quite resistant. We here present a new technique to produce small stable and steerable instruments without using pulling wires. Only three coaxial tubes are used. The middle coaxial tube is equipped with an original cutting pattern that allows the steering forces to be transmitted from the proximal to the distal end. The cutting is performed by means of a laser stent cutter. In this way the steering part is concealed in the wall of the tube. As a result, a large lumen is left that provides enough space for e.g. an aspiration catheter.

Material: Small coaxial Nitinol tubes (Minitubes, Grenoble, France) were laser-cut with a Rofin Stentcutter (Rofin Baasel Lasertech, Starnberg, Germany) in a specific pattern. The three tubes are assembled by sliding one into another. No gluing or welding is

needed. In a first testing set-up two steering instruments were used: one with an aspiration catheter and another with a cutting laser fibre. The instruments were used in conjunction with a modified endoscopic shaft constructed by means of rapid prototyping (Objet Eden Geometries Ltd, Rehovot, Israel). Procedures were simulated on a phantom.

Results: The simultaneous use of two instruments appeared to be very intuitive. The angle of motion of a single instrument is 50 degrees in any direction.

Conclusions: A new technique for the construction of steerable endoscopic instruments is presented. It allows working with two instruments simultaneously. In a first set-up only an aspiration catheter and a cutting laser fibre were used. The described design, however, allows to further include additional instruments such as a grasping forceps or scissors. Further experiments will be performed to evaluate these more extended possibilities.

Sonography-assisted cranial neuroendoscopy

K.D.M. Resch, Ch.B. Lumenta (Muenchen, Germany)

Objective: During last three decades operative ultrasound has developed markedly presenting a real-time imaging that can assist neuroendoscopy now. Data on capacity of application and spectrum of indications in neuroendoscopy are not spread widely. This paper is focussed on a 15 years experience of routine application of ultrasound combined with neuroendoscopy.

Materials: The ALOKA 5000 with small probes offered a basis to improve minimally invasiveness in our discipline: the small part sector probe (3.8–7.5 MHz, 1×2 cm), the burr hole probe (3.75–7.5 MHz, 0.8×0.8 cm) were used. A trans-endoscopic mini-probe (360°, 6F+8F, 10–15–20 MHz, 0.18 mm) was used with strictly indication in 100 cases. Different rigid neuro-endoscopes with 0°, 5° and 30°lense, 3 mm to 6.5 mm diameter, with canals for irrigation, outflow and instrumentation have been used.

Results: In more than 1500 ultrasound examinations and about 300 endoscopic operations, in about 150 cases combined technique was used. Most cases were done with transendoscopic ultrasound and also assisted endoscopy by a burr-hole probe and a highend sono equipment. Exact data will be presented regarding indication and results.

Conclusion: Ultrasound-assisted neuroendoscopy increases safety of the procedure and adds a real-time imaging to the endoscopy with a navigation capacity.

Neoderma: a new model for training in neuroendoscopy

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Introduction: Surgical endotrainers represent a great development in the teaching techniques used today throughout the world. With the ethical problems in utilizing cadavers, we also face the impossibilities to create specific pathologies, and by this practice being prohibited in a great number of countries, it becomes unavailable for the majority of the medical centres. The use of veterinary models has been strongly criticized by animal protection agencies, important limiting factor, also considering the fact that it will never be possible to create certain procedures, due to the fact of the anatomical differences to the human organs and also the lack of similar pathologies.

Material & Method: The surgical unit in Neoderma and the base in resin, allows in its neurosurgical module, the introduction of an endoscope in the lateral, third and fourth ventricular spaces, dilated by obstructive ventriculopathy. The training consisted in the identification of structures and lesions, allowing for the choice of the same instruments which would be used in real surgeries. The tumours were similar to gliomas, craniopharyngiomas, cysticercus, colloid cysts, etc. The removal of these lesions was performed as well as ventriculostomy with a Fogarty catheter. It was possible to identify important blood vessels like the basilar artery, and others. It also allowed bleeding by contact during excision.

Results: Around thirty five neurosurgeons with and without endoscopic background were submitted to the training. At the end of it, questionnaires were filled regarding opinions in every aspect of the experience. In summary, 88% of participants considered the training ‘Excellent’, 82% considered the model pretty similar to the human brain.

Conclusions: The Neoderma model was widely accepted by neurosurgeons with and without previous endoscopic training, with no need of cadavers, chemical substances and even laboratory.

Endoscopy guided by sonography

H. Velazquez-Santana, A. Santana, M.A. Barajas, R. Lopez (Guadalajara, Mexico)

Introduction: The intraoperative use of equipment in the operating room for the location of brain damage is already known. The implementation of big and sophisticated equipment (CT, MR) in the operating room reported a questioned utility due to economic and ergonomic reasons. Neuronavigation systems have the problem of modification of the structures once opened intracranial dura due the cerebrospinal fluid drainage. The use of diagnostic sonography in the nervous system is well known but the intraoperative utility is little known.

Material, method and Results: We report our experience with the use of trans-operative sonography in endoscopic treatment of brain lesions, and the very well ergonomics and economics characteristics.

Conclusions: The intraoperative sonography provides valuable support in the location of ventricular, paraventricular or deep brain lesions. Let you get real-time information during the surgical procedure as many times as necessary. Due to the characteristics of the sonography equipment (size, manoeuvrability, ergonomics, etc.) Offer greater benefits in comparison with the CT, MR or neuronavigation equipments. These obvious economic differences that make unfeasible the use of intraoperative CT or MR equipment for the majority of Latin American neurosurgical centres. So the intraoperative sonography was established as a very good option for the neuroendoscopic procedure in any latin american hospital.

Further experience with contact ultrasonic microprobe in adult and pediatric neuroendoscopy

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Introduction: The role of endoscopic procedures in adult and paediatric neurosurgery is rapidly growing not only for the treatment of different forms of obstructive hydrocephalus, but also for the other indications: various intracranial cysts and

intraventricular space occupying lesions. The different neuroendoscopic instruments and techniques for the membrane penetration and tumour removal have been developed such as blunt perforation, endoscopic scissors and forceps, mono and bipolar electrocoagulation and laser. This plurality of options demonstrates clearly insufficiency of the existing neuroendoscopic armamentarium and the necessity of developing new more suitable devices for neuroendoscopic procedures. We report our further experience with originally constructed contact ultrasonic microprobe ‘NECUP-2 in neuroendoscopy.

Material and methods: The newly developed ‘NECUP-2’ consists of the ultrasound generator {amplitude 300 μ m, intensity 900 W/cm², acceleration 400000 m/s², frequency 25000 Hz}, and titanium microprobe with 1.6 diameter which easily passes through the 2.2 mm ventriculoscope working channel. The ultrasound intensity can be changed from low to high enabling tissue perforation and removal with preserving of the vascular structures. All patients treated with ‘NECUP-2’ we previously informed and have signed written consent.

Results: Between June 1997 and June 2008, 134 neuroendoscopic procedures have been performed: 98 ETV, 12 septostomies, 19 arachnoid cysts and 5 intraventricular tumours. The ‘NECUP-2’ was applied in all cases in which blunt perforation was not possible: 33/98 ETV, 12/12 septostomies, 19/19 arachnoid cysts. In the five cases of intraventricular tumours neuroendoscopic procedure was combined with open microsurgery. The ‘NECUP-2’ was highly effective in all cases enabling safe fenestration and tumour removal with preservation of vascular structures. There were no complications related to ‘NECUP-2’.

Spinal Disorders

Evaluation of endoscopic discectomy and/or foraminotomy in lumbar radiculopathy

O.Y. Hammad (Cairo, Egypt)

Objective: To evaluate posterior endoscopic interlaminar lumbar discectomy and or foraminotomy (PEILDF) as a minimally invasive surgery, in patients with lumbar radiculopathy.

Methods: From 2000 to 2007, 122 selected patients with lumbar radiculopathy due to herniated lumbar disc (n=102), recurrent disc (n=8), recurrent foraminal stenosis (n=12) underwent endoscopy (2 patients went out the study). Patients included 66 males and 56 females with age range between 27–74 years (mean=44.6y). All patients underwent preoperative plain films (A-P, lateral dynamic views) and MRI on lumbosacral spine. Immediate postoperative A-P, and lateral dynamic view x-ray films, and CT or MRI on lumbo-sacral spine after one month (3D-CT on lumbo-sacral spine has been done for last 10 patients) have been carried out for all patients. Follow up period ranged between 6–72 months.

Results: Of 122 patients, 10 patients had motor deficit. Two levels discs in 4 patients were observed. Small dural tears occurred in 5 patients. One patient developed discitis. Two patients recorded superficial wound infection. Three patients with tight canal stenosis developed neurogenic deficit. Four patients reported miscounting disc level. Extraforaminal direction was recorded in

2 patients. Residual disc was observed in 3 patients. Excellent results were observed in 85 patients. Postoperative hospital stay duration ranged between 7–20 hours. Patients returned to normal work after a period ranged between 30–60 days.

Conclusion: Minimally invasive surgery in the form of PEILDF could be a good alternative to standard open surgery in disc prolapse. It offers less tissue destruction, less hospital stay, and early return to work. It obviates the need of implants in cases of recurrent discs. Complications are comparable for those occurred in standard surgery.

Endoscopic lumbar spine surgery with a new device

J.M.K. Oertel, M.R. Gaab (Mainz and Hannover, Germany)

Objective: The frequency of endoscopic spine surgery procedures is increasing. At present, almost every spine surgeon at least discusses the value of the endoscope in the various potential indications. However, not only that the indication for spinal endoscopic surgery in under intense and diverging discussion, many endoscopic systems available are difficult to apply and handle.

Material and Methods: The authors developed a new system for endoscopic spinal surgery. The main goals for this system were easy application and intraoperative handling and avoidance of a difficult and prolonged learning curve for experienced spine surgeons. The system consists of various dilators, two different working sheaths, a 30° optic fixed to the work sheath in a flexible position, and an endoscope holder. Through the work sheath almost all regular microinstruments can be applied.

Results: Since August 2006, 79 spinal surgeries have been performed with this system in lumbar disc and lumbar stenosis cases (mean age 51 yrs, range 22–83 yrs). In all intraoperative situations, the system was easy to handle. Mean surgical time scored 74 min. (range 28–168 min). A reduction of radicular pain was observed in all patients (100%). There was no emergency stopping, no mortality, and no infection. No complications peculiar to the application of the system occurred. In four cases (5%), the endoscope was abandoned and the procedure continued microsurgically. There was no neurological deficit and no CSF leakage. However, three recurrent disc prolapses (3.8%) occurred within the first year follow up.

Conclusion: In all, the system was easy and safe to handle. Good postoperative results were observed. However, the rather high rate of early postoperative recurrences needs further investigation.

Endoscopic transnasal odontoidectomy – a minimally invasive approach to decompression

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Introduction: Endoscopic transnasal odontoidectomy avoids common disadvantages of the standard transoral approach like prolonged intubation and nasogastric tube feeding, excessive tongue and oropharyngeal retraction, and need for palatal incision. However, the operation is technically demanding and lacks popularization. We report here our preliminary experience using this approach for anterior decompression.

Materials and Methods: From June 1998 to July 2008, the authors performed 500 endoscopic transnasal operations for patients with lesions around sella, clivus and craniocervical junction. Eight cases

are of irreducible basilar invagination or atlanto-axial dislocation with compressive myelopathy from rheumatoid arthritis, trauma and ankylosing spondylosis. All 8 cases received endoscopic transnasal odontoidectomy (with lower clivectomy) for anterior decompression and subsequent posterior fixation surgery with fusion to ensure stability.

Results: All 8 cases achieved well decompression of medulla and spinal cord and good neurological recovery with this operation. All patients were extubated after recovery from anesthesia and were immediately allowed to have oral intake after surgery. Postoperative endoscopic endonasal check-up showed good healing of nasopharyngeal incision wounds. Intra-operative cerebrospinal leakage from dura tear were encountered in 3 cases but resolved with conservative treatments.

Conclusions: Endoscopic transnasal odontoidectomy provides a minimally-invasive and feasible alternative to transoral operations for anterior decompression to craniocervical junction.

Endoscopic assisted far lateral approach to craniocervical junction

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Introduction: Extreme/far lateral approach to craniocervical junction is a surgical alternative to anterior routes. Its advantages include wide, sterile field, where surgical dissection is performed with standard microsurgical tools and occipitocervical fusion accomplished, in a single operation. However, in certain settings, especially craniocervical malformations, visibility obtained with microscope can be limited and complications may occur. The usefulness of endoscopic-assisted dens removal are examined.

Methods: Six silicone-injected cadaveric heads were dissected with aid of surgical microscope and rigid, 0-degree-angle endoscope.

Results: A flap incision was built and muscular dissection performed to expose the articular area, where anterior decompression took place and occipital squama and laminae of C1-C4. Vertebral artery was transposed from C2 to its dural entrance, under magnification of microscope. The occipital condyle, lateral mass of atlas and superior surface of C2 articular process were identified with endoscope. Drilling of the lateral mass of C1 was performed, preserving cortical margins and guided by the atlantal angle. Once identification of odontoid and dural compartments of spinal canal was performed, the occipital condyle was partially removed to expose the dens, from base to tip, and its removal was accomplished. With the endoscope, inspection of the degree of dens resection, integrity of dura and aspect of contralateral atlanto-occipital joint and C1–C2 joint could be performed.

Conclusions: Extra light and close-range visibility obtained with endoscope, associated with use of topographical landmarks as the atlantal angle during lateral mass drilling and dens removal may add for the safety of lateral approaches to craniocervical junction, especially in technically-challenging groups of patients.

Endoscopic C2 odontoid screw fixation with assistance of self-made bevel-shaped syringe tube

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Purpose: Internal fixation for C2 type II odontoid fracture could result in high union rate compared with stand-alone halo-vest external fixation. However, injury to the surrounding vital structure through anterior approach for odontoid screw fixation is not uncommon intraoperatively. Therefore we describe a simple technique allow us to perform the operation safely and less invasively.

Materials and Methods Four patients with C2 type II or rostral type III odontoid fracture were treated with odontoid screw internal fixation between 2006 and 2008. The patient was positioned in traditional fashion for odontoid screw fixation. A tubular retractor was made by 20 ml syringe, and tip side was cut in bevel-shaped about 60 degree slope. A horizontal skin incision about 3 cm in length was made at about C5 level. Under C-arm fluoroscopy and endoscopic view, odontoid screw was inserted into C2 odontoid process. Single buttress-threaded cannulated cortical screws were used in all of our cases. Only one patient received postoperative neck-collar immobilization. Both C-spine open-mouth & lateral view plain films were taken immediately and 6 month after the operation.

Results All these patients showed good bony union across the fracture line after the operation. No intraoperative trauma to the surrounding soft tissue was ever experienced. Besides, these patients experienced minimal throat discomfort and swallowing difficulty after operation.

Conclusions Endoscopic technique has provided magnified and close-up view compared with the traditional method, which developed by Ronald I. Apfelbaum (the RIA technique). The drawback of RIA technique for poor illumination and the need of special retractor are also improved by our endoscopic tubular technique. Thus such operation is transformed to be of minimal access, good illumination and clear visualization as well as absolute protection to the surrounding vital structures.

Parasitic Infections

Neuroendoscopic approach to intra cerebral cystic cysticercus. Technical description

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Introduction: Ventricular approach to neurocysticercosis is a usual toll in neuroendoscopy. However, intra cerebral forms usually are treated in a conventional way. We describe a technique to treat cysticercosis with endoscopic aid.

Material & Method: A 69 year old woman, treated for leukaemia, developed progressive dementia. A brain MR showed a left frontal intra cerebral cysticercus with mass effect. Because of the clinical condition, an endoscopic approach was advised. By a frontal burr hole, an endoscopic transcerebral approach was done. The cyst was penetrated with the endoscope and a small amount of the liquid content was released. After that, the endoscope was withdrawn from the cyst and a dissection was realized between the wall and the brain. The cyst was totally removed. The lady recovered well and was discharged 2 days ago. The dementia totally reversed.

Results: In our neuroendoscopic series, about 5% of the cases are due to neurocysticercosis. The majority of them are ETV or intraventricular approach to cystic lesions. Intracerebral approach

is succeeded in this case and seems to be another possibility in neurocysticercosis treatment.

Conclusions: Intracerebral neurocysticercosis was successfully treated with endoscopic technique and this is an option in special cases.

Endoscopic treatment of brain cysticercosis

J.A. Ramirez-Ceballos, R.M. Marquez-Castillo (Oaxaca, Mexico)

Introduction: Neurocysticercosis, is a current challenge for modern neurosurgery, it creates possibilities with neuroendoscopy. Progress with neuroendoscopy with better equipment, allow us the removal of the cyst and a fast recovery for our patients.

Material and methods: an analysis was performed, of the treatment results in patients with neurocysticercosis, that checked in the hospital from October 20th 2005 to February 20th 2008. These patients were considered candidates for surgical treatment for third ventriculostomy and if the case, the intraventricular or intracisternal removal of the cyst results of 16 patients with hydrocephalus, four with intraventricular lesions, three in lateral ventricles and a one with the 4th ventricle. Two with cyst in the premamillary cistern, these were removed via endoscopy, allowing the free circulation of CSF, minor brain damage and a fast recovery. Two of our patients required implantation of a derivative system due to persistence of hydrocephalus. Above all, neuroendoscopy lessens the reaction caused by the destruction of the cyst in the intraventricular environment and as it is well known that drugs to treat neurocysticercosis don't act in a ventricular level, this makes endoscopy an alternative for treatment of intraventricular cyst.

Endoscopy supra and infratentorial in ventricular cisticercosis

H. Velazquez-Santana, M.A. Barajas (Guadalajara, Mexico)

Introduction: Cysticercosis remains at present a public health problem in underdeveloped countries. More than half of all new cases of epilepsy in adults, is associated with neurocysticercosis in its active form (larvae) or inactive (calcification). Neuroendoscopy is the treatment of choice for ventricular cysticercosis due to the frequent presence of cysticerci in the ventricular cavities and the obstruction produced by mechanical or inflammatory action.

Material and method: We present our experience in 10 years of management of ventricular cysticercus (1998–2008), using rigid and flexible endoscopy. It included all adult patients with hydrocephalus (CT, MRI) and endoscopic confirmation of Cysticerci or its remnant. We describe the endoscopic characteristics of approaches to different ventricular regions. We show the considerations related to the great variability in the presentation of the larvae in the ventricular cavities.

Results: The possibility of cysticercosis in an adult patient (from rural areas of west Mexico) without tumoral or vascular hydrocephalus is more than 50%. The presence of complete or incomplete cysts in ventricular cavities is higher for the lateral ventricles and fourth ventricle. When the cyst is located in the fourth ventricle, its separated from the remaining ventricular system by mechanical or inflammatory reaction. The endoscopic characteristics of ventricular cavities associated with cysticercosis are: Changes in the visibility associated with an altered cerebrospinal fluid; opaque ependymal walls with ridges or pseudocav-

ities; accumulations of granular material on ependyma; vascular congestion and distal ependymal vessels rupture; and segmental obstruction of ventricular system. In patients previously treated with Albendazol or praziquantel the frequency of these characteristics was higher. Most patients received a second operation for shunt placement.

Conclusion: The presence of cysticercus and associated complications, make necessary the use of endoscopy as first method in the treatment for these patients. We suggest the medical treatment as complementary option, after removing the cysts of ventricular cavity.

The role of endoscopy in the treatment of subarachnoid cysticercosis

H. Velazquez-Santana, M.A. Barajas, A. Santana, R. Lopez (Guadalajara, Mexico)

Introduction: Over time, based on neurological (not neurosurgical) criteria, the value of surgery in subarachnoid cysticercosis has been underestimated. The surgical procedure was reserved almost exclusively in cases where the entrapment of cranial nerves and vascular structures was suggested. The most common example is the visually impaired by progressive cranial nerve entrapment. The application of this concept was in patients first treated medically, but even with the presence of cysticerci and one intense inflammatory reaction. The chronic inflammatory reaction reduced drastically the chances of functional recovery. Our experience in endoscopic and surgical treatment of patients with subarachnoid cysticercosis, shows the importance of the surgery as first treatment choice in these patients, because the best chance of functional improvement and preservation.

Material and method: we show our surgical experience in the treatment of adult patients who had subarachnoid cysticercosis in a period of 10 years (1998–2008). They were treated with microsurgical supraorbital approach and rigid endoscopy for the extraction of the cysts.

Results: The approach used more was the supraorbital. The first part of the surgery was with microsurgical technique, and the use of rigid endoscopy for the remove of deep cysts. We found a strong arachnoiditis when the patients were previously treated with antiparasitic drugs. We discuss the technical details and considerations for the future use of medical and surgical treatment in this cysticercosis problem.

Conclusions: The use of the endoscopy in the removal of subarachnoid cysticercus offers utility, especially in cases that have not received previous treatment with antiparasitic drugs. The best option in the cysticercose patients is surgical treatment first and then supplementing with antiparasitary treatment because the strong arachnoid reaction due the medication makes the surgery difficult and reduces the possibility of functional improvement.

The role of the endoscopy in persistent ventricular infection

H. Velazquez-Santana, M.A. Barajas (Guadalajara, Mexico)

Introduction: The presence of infection associated with shunts in patients with congenital hydrocephalus is known, however a small percentage of these patients may develop persistent infections. That is an important and difficult management problem.

Material and method: It is a prospective study of 6 years. We included pediatric patients with shunts and history of persistent neuroinfection. Persistent neuroinfection was defined as infection

treated with more than a full scheme of antibiotics. Upon admission, all patients had the valve system removed and an external ventricular drainage placed. The clinical and laboratory manifestations of infection in cerebrospinal fluid persisted. In these patients we performed endoscopic washout using a 0.9% saline solution at body temperature. We studied the pre and post endoscopic cerebrospinal fluid and determined pH, glucose, electrolytes, osmolarity, density, and protein. We compare the results of both samples and established the role of the washing in the results.

Results: Most patients require only one endoscopic washout to inactivate the infection of cerebrospinal fluid. Only one patient required 6 washouts to gain control of infectious. All patients, except 3 of them, received shunt operation. We showed the technique for endoscopic washout, and the possible role of the endoscopic washout in the inactivation of persistent infection.

Conclusions: The endoscopic washout in patients with persistent neuroinfection is useful in the inactivation of the infectious process. The hypothesis of the beneficial effect of endoscopic washout lies not only in the decrease of infectious agents, but mainly in the acute dramatic changes of the bacterial microenvironment, which makes it unfeasible to survive. This hypothesis merits further larger study.

Arachnoid Cysts

Double restore technique in suprasellar cysts: cysto-ventriculo-cisternostomy followed by shrinkage coagulation

V. Etus, S. Ceylan (Kocaeli, Turkey)

Introduction & Aims: Cyst recurrence and obstruction of the aqueduct by remnants of the cyst wall are the two main reasons for failure of endoscopic fenestration of suprasellar arachnoid cysts. We describe our experience with endoscopic fenestration of suprasellar arachnoid cysts followed by shrinkage coagulation of the cysts to restore the anatomy (double restore technique) in five patients.

Material & Method: Four children ranging in age from 7 months to 9 years and one adult 33 years of age were treated with the same technique. Endoscopic fenestration of the cyst dome and cystocisternostomy was performed followed by shrinkage of the cyst by means of endoscopic coagulation. All patients presented with symptoms of increased intracranial pressure (ICP) due to triventricular hydrocephalus except one child who had a coexisting precocious puberty. Follow-up studies included early and late postoperative magnetic resonance imaging, and cerebrospinal fluid (CSF) flow imaging and an endocrine profile if indicated.

Results: Satisfactory intraoperative cyst shrinkage was achieved in all cases, which was maintained on imaging studies at a mean follow-up period of 22 months. CSF flow imaging studies showed restored aqueductal CSF flow and patency of the ventriculocisternostomy orifice in all cases. None of the patients developed a procedure-associated morbidity. Symptoms related to increased ICP resolved in all patients. During a mean follow-up period of 41 months none of the cases required CSF shunt procedure.

Conclusions: The presented technique is safe and enables restoration of the anatomy of the third ventricle. Shrinking the cyst walls prevents obstruction of the aqueduct by free-floating

components of the cyst and reduces the risk of recurrence of the cyst from reclosure of the fenestration.

The role of ventriculo-cysto-cisternostomy as the sole treatment modality in suprasellar arachnoid cysts

N. Gazioglu, A. Kafadar, H. Biceroglu, B. Abuzayed, M.Y. Kaynar (Istanbul, Turkey)

Introduction: Endoscopic fenestration of intraventricular arachnoid cysts is an established treatment method. A subgroup of these lesions is suprasellar arachnoid cysts (SAC) which can be treated with a high success rate compared to other intracranial arachnoid cysts. We report 6 patients who were treated in our institution.

Material and method: Between 2001–2008 78 intraventricular neuroendoscopic procedures were performed in our department. Six of these cases were SACs. The ages of the patients ranged from 2 to 53 years with a median age of 25 years. The presenting symptoms and signs were headache, sixth nerve palsy in two pts, ataxia in two patients, bobble-head doll syndrome in one patient. All patients had hydrocephalus except one. Two patients had hyperprolactinemia. In all patients a ventriculo-cysto-cisternostomy was performed. Follow-up ranged from 7 years to 10 months.

Results: In all cases the primary surgical procedure was neuroendoscopic surgery. In all cases a ventriculo-cysto-cisternostomy was performed. There was no postoperative complications and none of the patients required additional shunt surgery. In all patients headache as the dominating symptom resolved postoperatively. The patient with head-bobbing was also symptom-free during the follow-up period.

Conclusion: Ventriculo-cysto-cisternostomy is an effective neuroendoscopic procedure in SACs. The good outcome of our patients shows that ventriculo-cysto-cisternostomy must be the surgical procedure of choice, although there are different surgical results in different series regarding the ventriculo-cystostomy.

Posterior fossa arachnoid cysts: endoscopic treatment in five cases

U. Godano, C. Mascari, V. Meleddu, L. Aste (Cagliari, Italy)

The treatment of posterior fossa arachnoid cysts is not well defined yet. The choice of the surgical options (direct open approach, shunting procedure, endoscopy) are still matter of debate. The recent development of minimally invasive approaches, further combined to endoscopic techniques, and their successful application to the surgical treatment for fenestration of intra and paraventricular CSF cysts opened a new insight in this field. Regarding arachnoid superficially located cysts, like many posterior fossa cysts, in which it is necessary to perform a fenestration into cisternal spaces we used an endoscopic technique in which the endoscope is used to view the operating field while micro-instruments, specifically designed, can be passed alongside the endoscope for surgical manouvers (endoneurosurgery). Five patients affected by symptomatic posterior fossa arachnoid cysts, superficially located (3 retrocerebellar and 2 in cerebello-pontine angle) underwent endoneurosurgical treatment: the cysts were reached directly through a burr hole on their surface, so that the endoscope was inserted into the cyst without passing through the brain parenchyma. We used a rigid endoscope, performing a wide

fenestration of the cyst in cisternal spaces (cystocisternostomy). The excellent endoscopic vision facilitated the surgical procedure with safe manoeuvres through a Key-hole approach. Compared to pure endoscopy, in which the instruments are inserted into the endoscope working channel, the advantage of endoneurosurgery consists in the possibility of using stronger instruments with a wider range of surgical manipulation, in order to realize a large and safer fenestration in a very dangerous area, around all the neuro-vascular cisternal structures. In all the patients, we observed the improvement of the symptoms. A significant radiological reduction of the cyst was observed in 2 cases. No mortality or major complications were observed. The authors discuss the role of endoscopic technique, which can be today considered a valid minimally invasive procedure for treating superficially located intracranial arachnoid cysts in the posterior fossa.

The endoscopic management of intracranial cystic lesions

T. Inagaki, K. Kawamoto (Moriguchi and Hirakata, Japan)

Introduction: The neuro-endoscopic management of intra and paraventricular lesions is a technique developed in recent years. Although favourable preliminary results in certain locations have been reported, optimal management of those lesions is still controversial. We retrospectively analysed our own cases treated with neuroendoscopically.

Material and Methods: In this paper, we included 19 patients treated in our institute. There were supra-sellar arachnoid cysts, Sylvian arachnoid cysts, intraventricular cysts, interhemispheric cysts and Cavum septi pellucidi. Endoscopy was performed using mainly rigid neuroendoscope. In some cases flexible neuroendoscope was used.

Results: Good results were obtained in approximately 80% of the patients. Second neuro-endoscopic surgery was required in one supra-arachnoid cyst. Open micro-surgery was required after neuro-endoscopic surgery in two cases. V-P shunt was needed in one case after neuroendoscopic surgery. Neither mortality nor morbidity was recorded in this series. Compared to shunt surgery and open microscopic surgery, neuro-endoscopic surgery required longer period to obtain the reduced cysts in size. To obtain good results, preoperative examination including MRI is needed to decide where fenestrations would be made. However in some cases second look surgery were required.

Conclusion: We discussed the benefit and limitation of neuro-endoscopic intra and paraventricular cystic lesion. The further improvement of both endoscopic equipment and instruments will be needed to obtain better results in future.

Neuroendoscopic treatment of intracranial cysts

L. Novak, B. Markia, L. Bognar (Debrecen, Hungary)

Introduction: Intracranial cysts are ideal pathologies for neuroendoscopic interventions. The main goal of the operations is to restore the normal CSF flow or to relieve the local pressure.

Material: In the last ten years sixty three patients underwent 68 operations on different forms of intracranial cysts. Suprasellar, intraventricular, septum pellucidum, quadrigeminal, porencephalic and arachnoidal cysts were included. Neuroendoscopic fenestrations, resections and assisted shunt placements were performed.

Results: In suprasellar and intraventricular cysts no reoperations were needed in almost all of the cases. In arachnoid cysts the success rate reached 80%.

Conclusion: In case of intracranial cysts both in adult and paediatric populations we also recommend endoscopy as the first choice technique. Our success rate is comparable to larger series and that depends on the pathologic condition.

Endoscopic treatment of posterior fossa arachnoid cysts in paediatric age. A series of 6 cases

P. Peretta, P.P. Gaglini, P. Ragazzi (Torino, Italy)

We report 6 cases of posterior fossa arachnoid cysts (PFAC) with hydrocephalus treated by endoscopic cyst fenestration. The posterior fossa is the second most common location of AC (22–27%). PFAC are often associated with hydrocephalus and macrocrania in pediatric cases. PFAC most commonly have been treated by cyst fenestration/resection or by cystoperitoneal shunting, but controversy continues regarding which surgical treatment is best. Six consecutive patients with PFAC were treated endoscopically between April 2002 and April 2008. In two cases the diagnosis was made by prenatal ultrasonography. The ages of the other four patients at the time of diagnosis ranged from 5 to 13 months. The neurological examination on admission revealed symptoms and/or signs of intracranial hypertension. The follow-up period ranged from 1 to 68 months. There was no mortality or morbidity. Symptoms were relieved in all patients and follow-up Magnetic Resonance Images revealed a decrease in the size of the cysts. The best way to prevent cyst recurrence and resolve hydrocephalus is to obtain communication of the cyst with the ventricular system and/or the subarachnoid space, taking care to protect many important neurovascular structures. Although the follow-up period is too short to make statements on long-term outcome and the series of patients is small, we suggest the minimally invasive endoscopic approach for treatment of PFCA as the first therapy of choice. Endoscopic treatment of PFCA proved to be an effective and safe technique with the advantage of shunt independence.

Neuroendoscopic treatment of middle fossa arachnoid cysts

G. Fernandez Molina, R. Jaimovich, R. Aldinio (Buenos Aires, Argentina)

Introduction: Arachnoid cysts are intra-arachnoidal collections of cerebrospinal fluid. They may have different shapes and sizes and are histopathologically benign. They generally have a congenital nature but they can also be the result of a trauma or infection. In some cases, they are communicated with the subarachnoid cavity, they may grow progressively and become symptomatic, therefore requiring surgery. We analysed 32 patients with middle fossa arachnoid cysts who were treated with a neuroendoscopic technique.

Material & Method: 32 patients with symptomatic middle fossa arachnoid cysts who underwent neuroendoscopic treatment are presented. The symptoms they presented were: severe headaches, convulsions, hemiparesis, dizziness, cognitive or learning deterioration, related to endocranial hypertension. All the procedures were carried out under general anaesthesia using a rigid neuroendoscope. A pterional approach was used in all cases, the exact place of the orifice being determined by previous MRI studies.

The technique applied provides enough cyst-cisternal communication. In the first 3 cases, a cyst-cisternal catheter was placed.

Results: In 31 out of 32 cases, the symptoms and the cyst size diminished. A patient with a hemispheric cyst developed a postoperative meningitis which showed good response to medical treatment. However, 6 months after the procedure, a cyst-cisternal catheter had to be placed due to cyst relapse.

Conclusions: The goal of the current treatment of symptomatic arachnoid cysts is to carry out excision or fenestration of the cyst by means of a communication between the cyst and the cisternal space through the simplest and most effective technique. The neuroendoscopic technique has shown to be a safe and efficient treatment which allows cyst fenestration and enough cyst-cisternal communication, and the patient doesn't have to undergo more complex and expensive procedures. Finally, being neuroendoscopy a minimally invasive technique, it requires a short hospital stay and allows quick recovery.

Endoscopic treatment of intracranial arachnoid and ventricular cysts in a pediatric series

C. Faria, J. Miguens (Lisbon, Portugal)

Introduction: Intracranial arachnoid cysts are frequently asymptomatic but can cause recurrent headaches, intracranial hypertension, focal deficits or cognitive problems. Its treatment is still controversial and can include cyst shunting, craniotomy and more recently endoscopic fenestration. The objective of this study was to analyse the efficacy, safety and the results of the endoscopic treatment in a paediatric series.

Material & Methods: We retrospectively reviewed 13 consecutive children with intracranial arachnoid cysts submitted to endoscopic treatment at our institution between 2004 and 2008. We performed in all cases an endoscopic fenestration of the cyst to the basal cisterns or to the ventricles.

Results: Patients were 8 males (62%) and 5 females (38%), aged 4 months to 8 years (mean age 2,8 years). Clinical symptoms were macrocrania in 7 patients (54%), hydrocephalus in 3 (23%), cognitive and speech impairment in 5 (38%), seizures in 2 (15%) and focal deficits in 1 (8%). Three patients (23%), including the 2 with seizures, were operated only due to significant mass effect or cyst growth in MRI. The cysts were intraventricular in 7 cases (54%), temporal in 5 (38%) and suprasellar in 1 (8%). Complications included one case of cerebrospinal fluid leak and one case of endoscopic procedure interruption due to technical problems. These 2 patients required shunts (a ventriculo-peritoneal shunt in the first case and a cysto-peritoneal shunt in the second). On follow up there was control of macrocrania and hydrocephalus in all patients (2 with shunts), cognitive improvement in 4 (80%) and improvement in focal deficit in 1 patient. There was reduction of cyst size in all cases, major in 9 patients (69%).

Conclusion: Our results confirm that endoscopic management of intracranial arachnoid and ventricular cysts is a safe and effective procedure and should be considered the method of choice to treat this pathology.

Endoscopic fenestration as treatment of choice for middle fossa arachnoid cysts. A series of forty patients

B. Spacca, J. Kandasamy, F. Giordano, L. Genitori, C.L. Mallucci (Firenze, Italy; Liverpool, United Kingdom)

Introduction: Middle Fossa Arachnoid Cysts (MFAC) are a relatively common, benign pathology but their management remains controversial with opposing views in the literature concerning indications to treat and surgical strategy. We report the combined experience of two centres of Pediatric Neurosurgery, Liverpool - UK and Firenze - Italy, on endoscopic treatment of middle fossa arachnoid cysts as treatment of choice. We analyze clinical and neuroradiological presentation, indications to treat, surgical technique, complications, clinical and neuroradiological follow up.

Material & Method: Between 2001 and 2007 forty patients, three adults and thirty-seven children, consisting of thirty males and ten females were admitted for middle fossa arachnoid cysts. Mean age at diagnosis was 7.8 years and mean follow up was twenty-one months. Fifteen patients (37.5%) presented with headache, macrocrania was present in nine (22.5%), eight (20%) had neurological focal signs, eleven (27.5%) had functional symptoms with epilepsy in eight (20%). Other non functional signs and/or symptoms, such as dizziness and failure to thrive, were referred by seven patients (17.5%). All patients were treated with endoscopic fenestration of the middle fossa arachnoid cyst into the basal cisterns. All the procedures were performed free hands with a rigid endoscope. The neuronavigation system was used in twelve patients (StealthStation Medtronic and StealthStation AxiEM technology Medtronic).

Results: Thirty-seven patients (92.5%) improved clinically at the last follow up. In four patients a second surgical procedure was required. Eight patients (20%) experienced a post operative complication but only three (7.5%) required further surgery. Cysts were reduced in sizes or disappeared in twenty-nine patients (72.5%) at last neuroradiological follow up.

Conclusions: Our data suggest that endoscopic fenestration of symptomatic middle fossa arachnoid cysts is a safe and effective procedure. We propose early consideration of this option in the management of middle fossa arachnoid cysts.

The neuroendoscopic treatment of cysts in the lateral ventricle

P. Zhao, X. Zong, X. Wang, S. Gui, F. Liu, Y. Zhang (Beijing, China)
A method of neuro-endoscopic resection of cysts in the lateral ventricle was evaluated in 52 patients. The technique combined craniotomy, corticotomy with small incision and bone flap, and cyst-ventricle or cyst-cistern ostomy to restore normal cerebrospinal fluid circulation. Neuro-endoscopic total resection was performed in 37 patients (71%) and partial resection and ostomy in 15 (29%). The total effective rate was 92%, with 67% (35/52) showing marked improvement in clinical symptoms, 25% (13/52) showing some improvement, and 8% (4/52) showing no effect. Postoperative pathological examination confirmed neuroepithelial cysts in 43 cases (28 with arachnoid cysts, 3 with choroid plexus cysts, and 12 with ependymal cysts). There were also 9 cases with other types of cysts. Thus, this treatment is a simple procedure that can be performed with reliable efficacy and fewer complications while increasing the rate of total resection.

Neuroendoscopic surgery of intracranial arachnoid cysts

Z. Novak, J. Chrastina, V. Feitova, I. Riha (Brno, Czech Republic)
Introduction: The role of neuroendoscopic surgery for arachnoid cyst is unequivocally accepted nowadays. Cyst volume reduction

after neuroendoscopy is occasionally reported not to be as marked as after shunting. The aim of the study is to present the results of neuroendoscopic treatment of intracranial arachnoid cysts.

Material and Methods: Since 1999, 62 patients underwent neuroendoscopic surgery for arachnoid cyst with adequate follow up. Middle fossa cysts prevailed (27 patients), followed by extratemporal (18 patients) and posterior fossa cyst (17 patients). The aim of surgery was to establish communication between cyst cavity and basal cisterns or ventricular system. Stereotactic frame Zamorano Dujovny (software Praezis) and neuronavigation system Brain Lab were used for presurgical planning.

Results: More than 50% cyst reduction was observed in 33.4% of temporal cyst patients and no reduction in 25.9%. Similar figures for extratemporal cysts are 64% (more than 50% reduction) and 23.5% (no reduction) and for posterior fossa 16.7% (more than 50% reduction) and 61.1% (no reduction). In posterior fossa cyst the patients with marked cyst reduction were older than patients without cyst reduction. No such difference was found neither in temporal, nor in extratemporal cases. Excellent results were achieved in 88% of temporal cyst patients with no difference in cyst reduction between excellent and poor outcomes. Excellent outcomes were achieved in 82.3% of extratemporal cysts and the percentage of patients with cyst volume reduction was higher than poor outcome patients. In posterior fossa cysts there were 67% of excellent results and the percentage of patients with cyst volume reduction did not differ between excellent and poor group. In 2 cases neuroendoscopic revision was required.

Conclusions: According to Helland (2007) 82% of patients after neuroendoscopy are symptoms free with more than 50% cyst size reduction in 66%. Our results are comparable with the exception of posterior fossa cysts. Presurgical planning using neuronavigation system or stereotactic software facilitates surgery together with patient safety and provides data for follow-up.

Colloid Cysts

Endoscopic trans-ventricular trans-choroidal approach for colloid cyst resection

V. Meleddu, U. Godano, C. Mascari, M. Bellinzona (Cagliari, Italy)

Endoscopic resection has recently become a well established treatment option for a third-ventricle colloid cyst. The main advantages of this technique compared to microsurgery are the less invasiveness, associated with less morbidity and mortality. From a technical point of view, the endoscopic operation is usually conducted through a frontal burr-hole and a transcortical, transventricular-transforaminal approach, in which the critical point are the surgical manoeuvres to be performed through the foramen of Monro. A problem related to the endoscopic treatment is the consistent number of cyst residues and asymptomatic recurrences, caused by the technical difficulties of completely removing the portion of the cyst attached to the roof of the third ventricle. We describe two cases of third-ventricle colloid cysts which were operated endoscopically using an alternative approach though a transventricular-transchoroidal route. The choice of this alternative approach passing through the choroidal fissure was dictated by the location of the cyst, which in one case was posterior to the foramen

of Monro while in the other case caused the widening of the fissure making this approach easier than the transforaminal one. We used both a rigid and a flexible endoscope in different moments of the procedure, as it is our policy for a better utilization of the peculiar characteristics of these two instruments. The opening of the choroidal fissure gave a larger and a more direct room for surgical actions, allowing a safer control of the entire cyst, particularly with respect to the venous structures. The internal cerebral vein ipsilateral to the side of the surgical approach is laterally displaced by the cyst and can be visualized and spared through this route. A great care is required for the manipulation of the fornix, which can be damaged during the procedure as in the transforaminal approach. The cyst content was completely removed, while the capsule remnants were widely opened and coagulated in a way difficult to obtain through the foramen of Monro. The results were good in both our cases with a complete recovery, without any postoperative sequelae. We stress the advantage of this approach, which allows in selected cases a wider exposure and control of the cyst, representing an extension of the endoscopic potential for the treatment of third-ventricle colloid cysts.

Neuroendoscopic removal of colloid cysts. Tap and Pullout Technique

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The paper describes the neuroendoscopic management of 30 consecutive cases of colloid cyst. A protocol based procedure includes presurgical plan to set up of access entrance, and surgical steps. Technique is based in anatomical concepts of cyst development. A graphic presentation of these anatomic landmarks is performed in order to explain and support surgical manoeuvres. Enlargement of Foramen of Monro, and use of specially designed tools as irrigation-suction cannula for tapping and a further capsule pull out, allows us the total removal of the lesion in a very fast mode. Clinical results have been discussed in order to justify this technique and the fact of the 28 cases of total removal without recurrence until now.

Endoscopic treatment of colloid cysts

C. Mascari, U. Godano, M. Le Fosse, V. Meleddu (Bologna and Cagliari, Italy)

During the last decade, endoscopic treatment of colloid cysts has improved surgical therapy for these intraventricular lesions, representing a safer and less invasive alternative approach respect to traditional microneurosurgery. However, endoscopic treatment still present some technical limits in reaching radical excision due to the difficulty in removing the cyst from the roof of the third ventricle. Indeed, technical limits are consistent with the currently available instrumentation, not always allowing optimal visualization of perilesional structure, and therefore the safe excision of the cyst from its origin. In our Institution we operated on 28 patients having endoventricular colloid cysts using the endoscopic surgical technique. Sixteen patients were male and 12 female, ranging in age from 20 to 75 years (median age: 38 yrs). One of the female patients had previously been operated on aspiration of the cyst performed through a stereotactic approach. Clinically, all patients exhibited symptoms due to intracranial hypertension, with progressive worsening toward lethargy in 5 cases. On MR

imaging, 23 patients showed cyst larger than 10 mm in diameter, and hyperintense signal images were exhibited by all the lesions: in 2 cases, there was no associated hydrocephalus. A rigid endoscope was used in 13 cases, a flexible endoscope in 6 cases, while both endoscope types were used in the remaining 9 patients in order to improve the surgical procedure, with better visualization of the neural structure and roof of the 3th ventricle. A neuronavigation device was used in 3 cases (in 2 patients without hydrocephalus, and in another one for targeting the localization of the cyst). Some critical issues in using the endoscopic technique in order to improve surgical efficiency have to be addressed: i. Surgical localization of the cranial burr hole for a correct endoscopic trajectory, and additional neuronavigation procedure; ii. Full instrument utilization for the endoscopic procedure (rigid and flexible endoscopes, together); iii. Possible enlargement of the minimally invasive surgical approach with a transforaminal-transchoroidal approach (two of our cases). Surgical procedures performed using both rigid and flexible endoscope have some advantages: they permit reaching the cyst portion inside the Foramen of Monro (rigid type), and checking the roof of the 3th ventricle detaching the cyst from it (flexible type). In our procedure, we had minor intraoperative bleeding in only 2 cases without any further clinical consequence. Operative results were clinically considered good in all 28 cases, although surgical excision was always incomplete due to a small cyst remnant attached to the roof of the 3th ventricle. Follow up controls showed cyst recurrence in 5 cases: 4 patients were treated with a second endoscopic procedure, while the fifth was treated with a trans-callosal microsurgical approach. The Authors will carefully discuss the endoscopic surgical technique, presenting the clinico-radiological follow up of patients.

Supraorbital endoscopic resection of colloid cyst

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Introduction: In the last decade endoscopic technique has developed as a ‘minimally invasive’ approach for resection of colloid cyst into the third ventricle. It is controversial whether a complete resection of the cyst is necessary to obtain a long term recovery. An anatomical limitation to a complete removal of the colloid cyst is the attachment of the cyst to the velum interpositum, that is difficult to visualize with conventional pre-coronal burr-hole approach, even if the burr-hole is placed some centimetres anterior to the coronal suture.

Material & method: In order to better control the attachment of the cyst to the roof of the third ventricle, we performed a supraorbital endoscopic approach guided by the neuronavigation station (Medtronic). We applied this technique to remove a colloid cyst in three patients with slight enlargement of the ventricular system. A right supraorbital burr-hole was done, and with the aid of the navigation system a rigid 12° endoscope was driven through the frontal horn of the ventricular system, medially to the caudate nucleus, along the direction of the foramen of Monro. The foramen, the fornix and the cyst were easily recognized. Continuous irrigation of the operative field with lactate ringer was maintained for all the procedure. With free-hand technique, the cystic wall was coagulated and punctured, and the colloid was

evacuated with grasping forceps and with continuous irrigation into the cystic space. This manoeuvre allows gentle retraction of the cystic wall and the visualization of the cyst attachment to the roof of the third ventricle.

Results: In order to avoid traction on the fornix, a subtotal resection of the cyst wall was accomplished in one case, where a small remnant of the cystic wall was left intact adhering to the velum interpositum. In no case at the end of the procedure an external ventricular drainage was positioned. Despite in one case a small piece of cystic wall was left adhering on the roof of the third ventricle, postoperative radiological images did not reveal any residual cyst in all cases. No patient manifested a neurological impairment after the procedure and all were discharged from hospital on fourth postoperative day. At mean radiological follow-up of 6 months, in no patient the relapse of the cyst was documented.

Conclusions: Our small series suggests that in patients with colloid cyst and enlargement of the ventricular system, the supraorbital approach allows a good visualization of the nervous structures and of the cystic wall with its attachment that is usually not visible with conventional approaches. With this approach a near complete resection of the cystic wall is possible, with no retraction of the adjacent structures and satisfying clinical results. A longer follow-up is needed to assess the efficacy of this technique.

Microneurosurgery for colloid cysts excision

I. Sbeih (Amman, Jordan)

We are presenting our experience in microneurosurgical excision in colloid cysts of the 3rd ventricle/Foramina of Monro, in 63 patients in the period between 1990–2006. Neurosurgical approaches included: Transcortical-transventricular in 50 patient and interhemispheric-transventricular approach in 13 patients. Mean average age in this series was 37 Years. There was a male preponderance of almost 4:1. Main presentations included headaches, visual symptoms, memory disturbance and decreased cognition. Total excision was achieved in all patients. There was no difference in the difficulty index of total excision in both approaches. There was no mortality in this series. Morbidity included CSF fistula, fever, subdural fluid collection, among others. There was no recurrence in any patient in this series with long term follow up. Postoperative epileptic attack occurred in one patient in the transcortical group although all patients received prophylactic anticonvulsant therapy for a period of 6 months. Endoscopic excision of these lesions is well accepted procedure. However all endoscopic series are done with the declared intention of total radical excision of the content and capsule of the colloid cyst in all patients. This intention was never achieved in any endoscopic series. In addition the recurrence of those cysts after endoscopic excision makes further endoscopic excision or even microscopic excision more difficult.

Endoscopic removal of colloid cysts of the 3rd ventricle

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Aim: The purpose of this report is to discuss the technical aspects of operating on the colloid cysts of the 3rd ventricle through a transventricular approach, with rigid endoscopes. We also focused on the technical problems for radical extirpation of cyst wall, as well as the problems of concomitant hydrocephalus.

Material and methods: We reviewed the cases of patients with colloid cysts of the 3rd ventricle, treated with endoscopic surgery during the last 7 years. Their clinical characteristics and radiological findings were analyzed and the operative techniques used were correlated to the final outcome. All the patients were evaluated with MR imaging for determination of cyst size, exact location eccentricity in the 3rd ventricle, anatomy of Monro Foramina, and cyst contents, as well as the ventricular size. We operated these patients using a rigid ventriculoscope long version system (Aesculap, Tuttlingen, Germany) with neuropilot IV stabilizing system.

Results: Fifteen patients (9 female and 6 male), with ages ranging from 25 to 65 years were treated. The follow-up period ranged from 6 to 24 months. The patients presented with headaches as the most common symptom, seizures, memory disturbances and coma (2 patients) due to ventriculitis and hydrocephalus with infected CSF drainage system. Total removal of the cyst contents and near total excision of the cyst wall was achieved in 9 patients, radical removal of cyst content and wall in 4 patients. Two cysts were obscured from scarring in the foramina of Monro and intraoperative hemorrhage with resultant disorientation due to loss of the crucial anatomical landmarks. Scarring or small foramina of Monro, hard cyst contents, intraoperative bleeding, cyst at the septum pellucidum are the problems that were difficult to overcome for safe removal of the colloid cysts. 13 patients with endoscopic removal of the colloid cysts improved neurologically and remained shunt free. One patient had a transient memory loss and improved after 2 months.

Conclusions: Endoscopic transventricular surgery for removal of colloid cysts of the 3rd ventricle provides satisfactory results, At present it is very difficult to remove the cyst wall for radical extirpation of the tumor. A variety of problems increase the technical difficulty of this procedure. Newer endoscopes with lenses of various angles (from 0 to 30 to 70 degrees) as well as with working channels of various sizes may facilitate operations that would otherwise be difficult or dangerous.

Pineal Tumours

Endoscopic surgery for pineal region tumours

M. Gangemi, V. Seneca (Napoli, Italy)

Tumours of the pineal region represent a major neurosurgical problem and their optimal treatment is controversial. Direct microsurgical approach is frequently indicated, but it involves many operative risks to the deep location and the presence of important vascular structures. On the other hand, the endoscopic surgery may play an important role in most patients with pineal region tumours, because it allows us to treat symptomatic hydrocephalus and to safely perform tumour biopsy under direct vision. We report our experience with 12 patients with pineal region tumours treated by endoscopic surgery. The procedure included in all cases third ventriculostomy for the correction of hydrocephalus, CSF sample for cytology and tumour markers, and tumour biopsy for histological diagnosis. Endoscopic biopsies showed a pineocytoma in three cases, a pineoblastoma in one, a germinoma in four, a low grade astrocytoma in one, a subependymoma in two and an atypical meningioma in one case. In this way,

the endoscopic procedure may allow us to select cases requiring a microsurgical approach (medium-sized or large non-germ-cell tumours) from cases to be treated only by irradiation and chemotherapy (germinomas and other malignant germ cell tumours). Then, in some patients with pineal region tumours the endoscopic procedure remains the only surgical treatment. When a direct microsurgical approach is indicated, it may be performed safely, in a non-emergency situation, and after correction of the hydrocephalus by endoscopic third ventriculostomy.

Endoscopic treatment for pineal and mesencephalic region tumours: review of 17 cases

F. Nigri, C. Telles (Rio de Janeiro, Brazil)

Introduction: Nowadays, the endoscopic third ventriculostomy (ETV) is the treatment of choice for tumoral obstructive hydrocephalus (TOH). When the tumour is located in the posterior part of the third ventricle it is also possible, in some cases, to obtain the diagnosis through an endoscopic biopsy. The authors report their experience with 17 cases.

Material: 17 patients, 11 males and 6 females, ages 5 to 66 (average: 26), with pineal and mesencephalic region TOH treated endoscopically from 1996 to 2008 were reviewed. In 6 cases a ETV and an endoscopic biopsy was performed at the same procedure.

Results: A total of 19 endoscopic surgeries, with 18 ETV, 1 septostomy, 6 tumoral biopsies and 1 case of tumoral aspiration, was performed. The histopathological diagnoses were: grade II mesencephalic astrocytoma (3 cases), Pineal germinoma (5 cases), falco-tentorial meningioma (1 case), oligodendroglioma of the posterior part of the third ventricle (1 case) pinealoblastoma (2 cases), pineocytoma (1 case), teratoma (2 cases), Inconclusive pineal tumour (1 case) and mesencephalic tumour without biopsy (1 case). The overall biopsy positivity was 67%, and when the pathologist was present at the procedure it raised to 100% (3 cases). We have one case of late haemorrhage, after three weeks of a TVE with endoscopic tumoral cyst aspiration and biopsy. All the patients remained shunt free except one that the ETV occluded after three weeks and the patient with late haemorrhage. Another case of ETV occlusion after radiotherapy was successfully treated with a new ETV. Previous radiotherapy (4 cases) did not compromise the procedure. The septostomy was performed in the late haemorrhage patient.

Conclusion: The neuroendoscopy permits, at the same procedure, through the same burr hole, the hydrocephalus treatment and histopathological diagnosis in a minimally invasive way, with very low rate of complications and acceptable accuracy.

Neuroendoscopy in paediatric pineal region tumours: towards reducing shunting and open biopsy

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Introduction: The role of third ventriculostomy (ETV) and timing of an endoscopic biopsy (EB) in paediatric pineal region tumours remains a topic of some debate. Does ETV avoid the need for shunting in all cases? Is the diagnostic success rate achieved by EB sufficient to justify any concurrent risk from the procedure? How often do we have to carry an open biopsy following an EB?

How often does an ETV combined with EB fail? We attempt to answer these questions and report our 5 year experience.

Patients & Methods: 17 consecutive children diagnosed between 2003–2008 with pineal region tumours, all under the age of 16 years were the subject of this review. The 10 boys and 7 girls were aged 4–16 years. CSF tumour markers and cytology was available in all cases and histological diagnosis obtained in 12/17. **Results:** Fourteen underwent ETV. Nine also had endoscopic-biopsies. 3 were negative requiring open surgical biopsy. Two of these were mixed cell tumours. There were no complications/deaths or technical failures in the neuroendoscopy group. Primary open surgical biopsy was performed in 4 cases. There were 6 Germinomas, 1 pineocytoma, 1 pineoblastoma, 2 astrocytomas, 2 mixed cell tumours. 4 had presumed low grade astrocytomas and one a presumed secretory germ cell tumour. One ETV required later shunting. CSF Cytology was negative. CSF & Serum Tumour markers determined therapy in one case and were non-contributory for the rest. Neuroendoscopy treated hydrocephalus successfully in 13/14 cases. It also allowed direct visualization for evidence of seeding. One-stage biopsy was possible but in one-third an open surgical biopsy was additionally required. Pineal & Mixed tumours were associated with repeat biopsies.

Conclusion: Endoscopy successfully manages hydrocephalus, avoiding shunting. Endoscopic histological diagnosis is helpful but it does not entirely obviate open surgical biopsies. The procedure has a low morbidity and is recommended as the initial intervention in conjunction with measurement of serum and CSF tumour markers.

Ventriculoscope tract recurrence after endoscopic biopsy of pineal germ cell tumours

S. Cavalheiro, N. Saba, A. Cappellano, A. Chassot (Sao Paulo, Brazil)

Introduction: Tumours localized in the pineal gland region have always been a challenge due to the difficulty to access the area for correct diagnosis with less morbidity. Tissue samples can be obtained by open surgery, stereotaxy, and neuroendoscopy. At IOP/GRAACC/Federal University of Sao Paulo the use of neuroendoscopy is the standard procedure because is minimally invasive and can be used for both histological diagnosis and third ventriculostomy, if necessary. Complications such as intraoperative postoperative bleeding, ventricular collapse, pneumocephalus, and tumour dissemination are seen in 5% of cases.

Objective: We report two cases of ventriculoscope tract recurrence of pineal germ cell tumour. **Materials and Methods:** Case 1: Male, 10 years old, with headache and vomiting for 10 days. The MRI showed a mass in the pineal region. An endoscopic third ventriculostomy (ETV) and tumour biopsy were performed and the pathology revealed a germ cell tumour. The serum/CSF AFP levels were also elevated; b-HCG levels were normal. He received four cycles of chemotherapy with carboplatin, cyclophosphamide, and etoposide and ended the treatment with negative tumor markers and a normal MRI. Nineteen months later, an elevated CSF b-HCG was found and the MRI revealed a mass in the ventriculoscope tract. He was treated with two cycles of cisplatin, cyclophosphamide, and etoposide; 45 Gy cranio-spinal radiation

therapy; and autologous BMT. After 5 years of follow-up there are no signs of tumour recurrence. Case 2: Male, 16 years old, with a history of headache and vomiting for a month. MRI revealed a mass in the pineal region and hydrocephalus. A neuroendoscopic procedure with tumour biopsy and ETV were performed and the pathology showed germ cell tumour (germinoma and embryonic carcinoma). He also had elevated serum and CSF AFP levels; b-HCG levels were normal. He received six cycles of chemotherapy with carboplatin, cyclophosphamide, and etoposide with normalization of AFP levels but still with residual tumour at MRI. An open surgery was performed to remove completely the lesion and revealed components of yolk sac tumour. Radiation therapy was administered at 24 Gy in the supratentorial ventricular region with a boost of 45 Gy at the pineal area. He ended the treatment with negative tumour markers and no sign of residual tumour. One month later, in a routine MRI, both infratentorial region and ventriculoscope tract recurrence was observed. The serum/CSF AFP level was again elevated. He is now receiving chemotherapy with some response.

Conclusion: Although neuroendoscopy has proved to be a procedure with low cumulative postoperative mortality and morbidity, the potential for tract recurrence is supported by the literature and should be considered. New approaches should be studied to minimize or even avoid these complications, if possible.

ETV stoma: early study with autopsy, dissections and microscopy, in a case of posterior fossa surgery and ETV, complicated by DVT and PE

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Introduction: The aim of this study was to investigate the early structural and histopathological changes developed on the floor of the third ventricle, after perforation and expansion of the stoma, during ETV, and the possibility of these changes to correlate to late failures of the procedure. To our knowledge no publications have addressed this issue till now.

Material & Method: A-42-year old female underwent a posterior fossa meningioma resection, immediately after ETV, for associated obstructive hydrocephalus. Surgery was uneventful, but at the admission to the neuroICU, she had cardiopulmonary arrest and died despite CPR. Pulmonary embolism was diagnosed at autopsy, which also included, among others, observations dealing with the ETV. The brain was fixed in 10% formalin solution for further study of the third ventricle floor, using operating microscope and microdissections. Finally, light microscopy was applied to study tissue sections from the third ventricle floor, proximal and distal to ETV stoma.

Results: Autopsy observations, microdissections and histology data were indicative of surgical trauma and local response to this, the grade and extension of which, almost directly after the surgical procedure, were searched and documented.

Conclusion: The results of the study disclose the early local response to the perforation of the third ventricle floor, which may represent a possible factor affecting the late outcome of ETV.

Indications and limits of neuroendoscopy in the management of tumoral pathology in paediatric patients

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Neuroendoscopy is increasingly used in the management of brain tumours and tumour-related hydrocephalus. In this retrospective study we describe the surgical strategies of endoscopic treatment and the postoperative outcome in an heterogeneous series of patients with CNS tumours. Between 1996 and 2008 at our Institution, 159 endoscopic procedures were consecutively performed in 137 paediatric patients (72 male patients and 65 female patients ranging in age from 1 month to 20 years, mean age 101,6 months). 18 patients underwent two endoscopic procedures and 4 patients underwent three of these procedures. In 66 patients affected by posterior fossa tumour, endoscopic third ventriculostomy (ETV) was performed for hydrocephalus treatment. At follow-up 55 of these patients were shunt-free. In the other 71 patients (58 supratentorial tumours, 13 pineal region) different endoscopic approach (ETV, septostomy, cyst wall fenestration, biopsy sampling, tumour removal, catheter insertion) were performed. Overall 20 patients were submitted to tumour biopsy, 10 patients to partial removal and 1 to a total extirpation of the tumour. One patient died (0,6%) from diffuse brain oedema on the 1st postoperative day after endoscopic biopsy sampling of a basal ganglia tumour. No permanent morbidity related to endoscopic approach was observed. The ETV is the ideal treatment for obstructive tumour-related hydrocephalus because of the high successful outcome and the low complication rate. Neuroendoscopy procedures offer the opportunity to combine in selected cases (i.e. metastatic ventricular dissemination, cystic lesions) tumour biopsy, marsupialization and treatment of hydrocephalus. In limited numbers of patient with small solid pedunculated intraventricular lesions partial or total tumour removal could be performed. Careful selection of surgical candidates on the basis of preoperative radiological examination conduce to reduction of complication rate and technical failures.

Ventricular Tumours

Ventricular cystic tumours: neuroendoscopic treatment

P.A. Oppido, C.M. Carapella, F. Cattani, E. Morace (Rome, Italy)

Introduction: Surgical removal of ventricular tumours, can be followed by CSF-pathways obstruction due to postoperative cyst. In the past, microsurgical opening of these cysts was the only possible treatment to control intracranial hypertension. Up today, neuroendoscopy is the most common procedure to open ventricular arachnoid cysts, but experience in cystic tumours is limited.

Methods: From 2001 to 2008, 8 patients (6 male and 2 female, aged from 16 to 66 years) presented at the MRI large cysts blocking CSF flow and elevated ICP. In 5 patients there was associated hydrocephalus. The tumour diagnosis was: trigonal metastasis, pineal malignant teratoma, occipital oligoastrocytoma, frontal GBM, 4th ventricular epidermoid, and 3 craniopharyngiomas.

Results: In 6 cystic tumours fenestration in the ventricular space was endoscopically performed. In 2 cases septostomy, in 2 ETV and in 1 aqueductoplasty were associated, too. In 3 craniopharyngioma, under direct visual control, an intracystic catheter was introduced and connected to Ommaya reservoir for subsequent intracavitary chemotherapy. Postoperatively, there were no morbidities, nor mortality. Only in 2 cases, after 1 month, there was cyst recurrence. In 1 cyst fenestration was repeated, in another microsurgical

gical tumour removal was preferred. In the follow-up, between 1 and 7 years, 5 patients show no intracranial hypertension recurrence, nor tumour progression. After 6 months and 11 months since neuroendoscopy, respectively, 2 patients died from tumour progression, without cyst regrowth.

Conclusions: In ventricular cystic tumour neuroendoscopic fenestration is an effective and safe alternative instead of microsurgical removal to treat intracranial hypertension, by restoring CSF flow.

Role of endoscopy in pediatric intraventricular tumours

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Lateral and third ventricular regions are affected by various kind of benign and malignant tumours frequently in younger age groups. To deal with them is challenging, as anatomically these regions are quite deep seated and need to be approached in a way to minimize trauma to eloquent cortical areas as well as major neurovascular structures. Functionally important nearby structures also need to be taken care of, while approaching and excising these lesions. We have operated on 170 cases of intraventricular tumours, out of which 51 were in paediatric age group. This data has been analyzed for role of endoscopic biopsy and possibility of resection. In most of the cases treated by microsurgical resection, we have used endoscope assisted technique in selected cases and found it a very useful adjunct.

Endoscopic options in intra- and paraventricular low grade gliomas

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Intra- and paraventricular low grade gliomas particularly when associated with CSF circulation obstruction might represent ideal candidates for neuroendoscopic approaches. The authors present their data from procedures performed from February 1993 until October 2008. Out of 245 endoscopic procedures for CSF restoration in tumours (113) or direct endoscopic tumour biopsy and / or resection (132) performed between February 1993 and October 2008, only 28 were performed in low grade gliomas. The endoscopic procedure performed and the surgical outcome was prospectively evaluated. There was no emergency stopping of any endoscopic procedure. An endoscopic third ventriculostomy was performed in 20 cases for restoration of CSF circulation because of CSF circulation obstruction in 20 cases of low grade gliomas of the midbrain and the pons. The ETV was initially clinically and radiologically successful in 18 (90%). However, 6 out of 18 patients required shunting during the follow up period within a mean interval of 2 years. There was no endoscopic procedure related complication. In eight cases, endoscopic tumour resection (3 cases) or tumour biopsy (5 cases) was done. While the tumour biopsy was done without any complications and revealed a definite diagnosis in all cases, the tumour resection of two out of three subependymomas was too time consuming and a switch to microsurgical resection was performed. In all, the endoscopic technique represents a safe and effective therapeutic option in intra- and paraventricular low grade gliomas. For CSF restoration, the endoscopic third ventriculostomy in midbrain and pontine low grade gliomas is a valuable therapeutic option although shunting might be required subsequently during further progression of the disease. For tumour procedures, the technique is of particular

value in biopsy procedures while the attempt of endoscopic low grade glioma resection should be limited to tumours of the size of 1.5 to 2 cm maximum diameter.

Endoscopic approach of lesions in the thalamo-mesencephalic region

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Introduction: The microsurgical access to the posterior region of third ventricle is complicated, especially when the tumours involve the thalamus or mesencephalic structures. The development of neuroendoscopy has allowed access to these regions and to obtain material for diagnosis and complementary therapy.

Material and method: We present 8 patients with solid and cystic lesions in the thalamo-mesencephalic region and demonstrate the endoscopic access to this region.

Results: The patients were operated through frontal precoronal burr-hole access, 4 cm in front of coronal suture for the posterior region of third ventricle, and another coronal for access to do premamillary fenestration for resolution of the hydrocephalus. Histopathologic study showed in four patients the presence of 4 high grade gliomas and in two, cystic low grade gliomas. We present the technical details of the approach and the endoscopic considerations in this type of tumours.

Conclusions: Neuroendoscopy can safely and quickly access the thalamus-mesencephalic region to obtain biopsies of solid tumours, and place catheters to drain cystic lesions, making a fast diagnosis to receive additional radiotherapy treatment.

Endoscopic management of intra-ventricular tumours

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Object: The study is aimed at evaluating neuroendoscopic procedures in the management of intra-cranial intra-ventricular lesions at two major centres in the Middle East region.

Methods: We review, from a prospective database, 24 consecutive patients with various intra-ventricular lesions and hydrocephalus (in most of the patients), who were operated and managed by the primary author. Depending on the pre-operative imaging and working diagnosis, endoscopic biopsy or endoscopic resection/debulking, along with concomitant treatment of hydrocephalus via third ventriculostomy or fenestration of the septum pellucidum and ventriculo-peritoneal shunting, were done.

Results: The single endoscopic procedure was successful in most of the patients, where the goals of surgery in attaining a diagnostic biopsy or resection, and simultaneous treatment of hydrocephalus, were attained helping guide further therapy. The endoscopic procedure was the only procedure needed in most of the patients.

Conclusions: Endoscopic procedures carried a high success rate and minimal morbidity, and were especially valuable in patients harbouring chemo and/ or radiosensitive deep seated tumours.

Overview on neuroendoscopic biopsy in ventricular tumours

P.A. Oppido, F. Cattani, I. Cordone, E. Morace (Rome, Italy)

Introduction: Ventricular tumours represent a heterogeneous group for histology and therapy, with often common clinical history and radiological aspect. They can be benign or malignant lesions, to simulate malformative or infectious lesions, and need specific therapy, sometimes surgery, in other cases radiotherapy or

chemotherapy. Neuroendoscopic biopsy is a safe and minimally invasive procedure to establish diagnosis and subsequent specific therapy for ventricular tumours. At the same time intracranial hypertension can be treated by ETV or septostomy.

Material: from 2001 to 2008 we reviewed only 16 patients operated on for endoscopic biopsy. 2 patients were children and the others adult were from 23 to 79 years of age. In 9 patients tumour was in the lateral ventricle, in 5 in the third ventricle and in 2 extending from the lateral ventricle to the third ventricle. In addition to conventional histopathology in 3 cases the CSF sample and tumour tissue were analyzed by flow cytometry immunophenotyping for detection of tumour biomarkers. In 4 patients ETV, in 2 the septostomy and in 1 cyst fenestration were performed. In 2 an Ommaya reservoir for ventricular chemotherapy was inserted. In 4 vascularized tumours the Tullium laser was helpful.

Results: The histology was: 8 malignant glioma, 1 metastasis, 1 malignant teratoma, 1 radionecrosis, 1 non-Hodgkin lymphoma, 1 craniopharyngioma, 1 subependymoma, 1 ependymoma, 1 non specific tumour. This one was definitely a PNET. In 3 patients, neuroendoscopy was followed by tumour microsurgical removal, confirming the endoscopic diagnosis in 2 cases. In 3 third ventricle tumours and in 1 lateral ventricle tumour by ETV the hydrocephalus was treated. Intracranial hypertension control by septostomy or ETV was possible and 12 patients were treated by chemotherapy and radiotherapy. In 1 ependymoma the tumour dissemination along the ventricle was visualized by endoscopy. In 1 malignant glioma a partial tumour resection was tempted. Only in 1 case there was intratumoral haemorrhage.

Conclusions: Neuroendoscopic biopsy is valid procedure for ventricular tumours diagnosis. ETV and septostomy can control intracranial hypertension for subsequent specific therapy. New CSF and tissue biomarkers analysis can improve diagnosis and adjuvant therapy. The laser is helpful for tumour resection and bleeding control

Purely endoscopic approach to intraventricular lesions

S. Cavalheiro, J. Mendonza, A. Chassot, D.F. Ierardi, P. Dastoli, S.T. Zymberg, N.J. Silva (Sao Paulo, Brazil)

From 1996 to 2008, intraventricular lesions of 87 patients under 18 years of age were treated by pure neuroendoscopy in the Pediatric Oncologic Department of the Federal University of Sao Paulo, Brazil. In 30% of those patients the lesion was totally resected, but in the remaining 70% only biopsy was achieved. The majority of the cases consisted of tumours located in the posterior part of the third ventricle. In the last four cases, an ultrasonic aspirator connected to the endoscope accounted for the improved quality of the resection. This initial experience with the ultrasonic aspirator attached to the endoscope proved it to be an excellent tool in helping surgeons to obtain better *Results*. In the beginning, only monopolar and manual aspirators had been used, and in a few cases it had been possible to achieve complete resection. However, when associated bipolar and laser coagulation were used, the number of total resections increased. It was possible to thoroughly resect intraventricular lesions with little bleeding or no bleeding at all. Nevertheless, although the tools for pure neuroendoscopy have already improved a lot, they are still far from constituting the ideal equipment for this technique.

Endoscopic approach of posterior fossa tumours

M. Sisaber, M. Iguertsira, K.A. Bouyoucef (Blida, Algeria)

Objective: The success of neuroendoscopy in recent years has relied heavily on the success of ETV. Now, however, the field of neuroendoscopy is prepared to extend beyond just ventriculostomy procedures. The endoscope is currently being used for all types of neurosurgically treatable disorders: intraventricular tumours, skull base tumours, intracranial cysts, and rare subtypes of hydrocephalus. We report the results of a pilot clinical trial exploring the safety and feasibility of a new endoscopic approach to the posterior fossa tumours, particularly those of the brainstem or the fourth ventricle. The endoscopic transchoroidal approach provides a direct vision to the total cavity of third ventricle and an easy access to the fourth ventricle through a dilated aqueduct. The use of neuronavigation can be more accurate.

Methods: From an experience at the author's institution of almost one thousand neuroendoscopic procedures, among which 160 concerned intraventricular lesions, 18 were selected which were in the posterior fossa. Between January 2007 and November 2008, 18 patients (8 female & 10 male) with posterior fossa tumours; 7 in brain stem and 11 in the fourth ventricle were treated upon using an endoscopic procedure. Through a frontal burr hole with rigid endoscope we reached these tumours, after ETV through the stoma in 4 cases and through the aqueduct in 14 cases (one by opening the choroidal fissure). The follow up ranged from 1 to 21 months.

Results: In all patients, endoscopic biopsy of the post fossa tumours has been successfully performed; we observed one case of ophthalmoplegia postoperatively. The histo-pathological diagnosis was: 4 medulloblastomas, 9 astrocytoma low grade, 2 astrocytoma high grade, 3 Ependymomas. Benign tumours are reached by open surgery and malignant underwent chemotherapy and radiotherapy without surgery.

Conclusion: This approach appears to provide a new efficient treatment for posterior fossa tumours and a prelude to the future of Minimally Invasive Neurosurgery. We think that it is feasible and reasonably safe, provided that the surgeon has extensive experience in neuroendoscopy.

Vascular Disorders-Tumours

Transventricular endoscopic removal of thalamic haemorrhage

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Introduction: Thalamic haemorrhage has been less surgically indicated because of deep location and invasiveness of surgery. Transventricular endoscopic approach provides ideal and less invasive haematoma removal without injury of important structures. Endoscopic procedures will be reported together with results of our series.

Materials and methods: A total of 9 cases with thalamic haemorrhage were treated by this procedure. Endoscopic approaches were performed through the anterior horn of the lateral ventricle, by ipsilateral or contralateral approach from a precoronal burr-hole. Associated intraventricular haemorrhage was removed simultaneously, and third ventriculostomy was performed if necessary.

Results: Endoscopic approach was ipsilateral in 5 cases and contralateral in 4 cases, the approach was decided based on extent

of the thalamic and intraventricular haemorrhages. Mean score of preoperative GCS was 7.56, and mean postoperative score at 1 month was 9.22. Remarkable improvement of motor function was observed in 2 cases, whereas most important determinant factor of postoperative prognosis was preoperative clinical status. **Conclusions:** Transventricular route navigates directly to the thalamus through the usual anterior ventriculostomy, which is ideal and less invasive. Frequently associated intraventricular haemorrhage can be treated simultaneously, and enlarged lateral ventricle plays a role of a corridor toward the target. Surgical indication of thalamic haemorrhage can be extended by this procedure, and decompression of brainstem may result in better prognosis.

The impact of neuroendoscopic aspiration of intraventricular haemorrhages on shunt-dependency

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Introduction: Massive intraventricular haemorrhages require aggressive and rapid management to decrease intracranial hypertension. The amount of intraventricular blood is a strong prognostic factor, and its fast removal is a priority. Neuroendoscopy may offer some advantages over more traditional surgical approaches. We describe here the technical details and clinical outcomes of 50 consecutive patients endoscopically treated for haematocephalus, highlighting the potential pitfalls and the advantages of the technique.

Material and Methods: We retrospectively reviewed clinical and radiological data of fifty patients (aged 7–80 years) presenting with massive ventricular haemorrhage admitted between January 1996 and June 2008 to our neurosurgery unit. Severity of ventricular haemorrhage was graded according to the Graeb scale; the mean Graeb score was 9.8 +/- 2.9. Haemorrhages were secondary to ruptured aneurysms in 31% of cases; from bleeding of AVMs in 8%; secondary to primitive intracerebral haemorrhage in 39%; pure intraventricular haemorrhage in 16% and posterior fossa haematoma in 6% of the cases. A flexible endoscope with “free-hand” technique was always used.

Results: The procedure was successfully completed in all cases. The ventricular cleaning proceeded in three phases: lateral ventricle, third ventricle, and then aqueduct and fourth ventricle. In selected patients, a ventricular catheter for intracranial pressure monitoring and CSF drainage was positioned. There was no surgery-related mortality. The mean length of intensive care unit stay after the operation was 19+/-12 days. Short-term mortality (1 mo) was 18%, whereas long-term mortality (>6 mo) was 27%. Complete recovery (Glasgow Outcome Scale score 5) was achieved in 30% of cases, moderate disability (GOS 4) in 9%, severe disability (GOS 3) in 30% and persistent vegetative state (GOS 2) in 4% of patients. A ventriculo-peritoneal shunt was necessary in only 20% of patients.

Conclusion: Intraventricular haemorrhage, as other ventricular diseases, can be treated successfully with flexible endoscopes. The limitation of this study lies in its observational nature; however, the encouraging results reported especially on shunt-dependency should prompt a randomized study to evaluate the effectiveness and efficiency of our approach in comparison to the more established semiconservative management offered by external ventricular drainage and or fibrinolytic agents.

Draining parenchymatous haematomas using a rigid endoscope through a 1.5 mm craniectomy

J.A. Ramirez-Ceballos, R.M. Marquez-Castillo (Oaxaca, Mexico)

Objective: To study the result of drainage of parenchymatous haematomas caused by hypertension, through a 1.5 mm craniectomy, using a 2.7 mm rigid endoscope.

Material: Patients that checked in the hospital from September 2005 to May 2007. These patients were included with a diagnosis of parenchymatous haematomas caused by hypertension with a volume over 30cc, and with progressive neurological deterioration and a lower grade on the Glasgow scale or more than two points in less than 24 hours. And a shift in the midline higher than 0.5 cm

Method: For this procedure a small craniectomy was performed, of 1.5 cm so it would allow a small cylindrical separator and a rigid endoscope of 2.7 mm. This would also allow us to employ other instruments commonly used.

Results: 27 surgeries were performed in 27 patients to drain parenchymatous haematomas, through endoscopy, performing a 1.5 mm craniectomy that will allow the drain without any further complications, and a quick recovery for the patient with an average postoperative bleeding of 150 ml and no intraoperative or postoperative complications

Conclusions: We consider the drain of parenchymatous haematomas by endoscopy a very trust worthy alternative. It reduces the surgical time and also the bleeding, and the patients' recovery is very fast. Using a cylindrical separator permits us a better visualization of the haematomas and less damage on brain tissue.

Endoscopic treatment of hypertensive cerebellar infarction

L.C. Alencastro, L.F. Alencastro, A. Lodetti, C. Martins, M. Faria (Porto Alegre and Recife, Brazil)

Introduction: New techniques and surgical tools have recently widened the possibilities for endoscopy application in the treatment of intraparenchymal lesions. Many mass effect lesions can be potentially treated by an endoscopic approach. The objective of this study is to demonstrate the technique of endoscopic treatment of cerebellar infarction with mass effect and distortion of structures in the posterior fossa, presenting the concept of ‘instruments that see’.

Material and Methods: Three patients with cerebellar infarction due to obstruction of the posterior inferior cerebellar artery (PICA) have been treated with trepanation of the posterior fossa and resection of infarcted cerebellar tissue. For that purpose, a Storz 0°, 18 cm Hopkins endoscope combined with a special sheath designed by the authors that has a suction tube attached to it have been used.

Results: The internal decompression of infarcted cerebellar tissue was successfully accomplished with complete relief of posterior fossa hypertension. An almost bloodless working field was achieved and shortening of the surgical time, when compared with standard technique, was observed. No new morbidity was associated with the method.

Conclusion: Endoscopic technique has proved to be safe and effective for resolution of posterior fossa hypertension due to cerebellar infarction in these cases. Avoidance of a large craniotomy and the bloodless working field can shorten the duration of the procedure and possibly help reducing morbidity.

Endoscopic evacuation of intraventricular haemorrhage

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Introduction: The treatment of acute intraventricular haemorrhage is still debatable. In case of obstructive hydrocephalus, positioning of an external ventricular drainage is a common procedure although with the high risk of catheter obstruction. Intraventricular thrombolysis with rt-Pa and urokinase has been described with rewarding results since more than a decade, even though no definitive indications have been proposed for its clinical routinely use. Lately few authors have described the endoscopic evacuation (EE) of intraventricular clots as a treatment option for such cases.

Material & method: From March 2008 to December 2008 we have treated endoscopically at our institution six patients with intraventricular haemorrhage. All patients presented with signs of raised intracranial pressure and with radiological evidence of moderate to severe obstructive hydrocephalus. All but one patient were treated with an urgent procedure from 6 to 12 hours after the haemorrhagic event; a patient was treated 36 hours after the haemorrhagic event for the increasing of the haemorrhage and delayed neurological deterioration. In three cases a flexible endoscope and in the other three patients a rigid endoscope was used. The endoscope was inserted in the right frontal horn through a burr hole placed three to five cm anterior to the coronal suture along the midpupillary line. Initially CSF appeared in all cases as haematic, and precluded the good visualization of the intraventricular anatomic structures. After prolonged irrigation, the foramen of Monro, septum pellucidum, and third ventricle became visible in all procedures and the third ventricle with aqueduct was inspected. Partially organized haemorrhagic clots were detected and removed in small pieces and with the aid of the suction tip, until the Monro foramen and the aqueduct were cleared. In the case of the patient treated 36 hours after the haemorrhage, the gross organized clots prevents a satisfying fragmentation and removal of the blood. In four patients a third ventriculostomy was performed and in five the septum pellucidum was fenestrated. At the end of the procedure, in all patients an external ventricular drainage was positioned under direct endoscopic visualization. In no patient we observed complication related to the procedure. A postoperative CT scan was obtained in all patients to assess the patency of the foramen of Monro and the aqueduct.

Results: Three patients manifested a prompt improvement of the neurological status with complete neurological recovery. In one patient a late open surgery procedure was carried out to remove an arteriovenous malformation fed by distal branches of the superior cerebellar artery. Another patient was submitted to radiation therapy for a small caudate nucleus arteriovenous malformation.

Conclusions: Our experience suggests that the ventricular exploration and endoscopic drainage of intraventricular clots is a useful treatment option for patients with intraventricular haemorrhage and signs of ventricular dilatation. The procedure is safer than the intraventricular thrombolysis and the clinical results appear to be satisfying. We suggest the EE procedure as the first choice treatment for intraventricular haemorrhage; the earliest the surgery the better the results. Rigid endoscope permits sharper visualization and better control of the suction tip, while the flexible one is best for intraventricular exploration.

Endoscopic treatment of recurrent chronic subdural haematomas

J.A. Ramirez-Ceballos, R.M. Marquez-Castillo (Oaxaca, Mexico)

Introduction: Subdural haematomas surgery is one of the most common procedures in current neurosurgery, with satisfactory results in 95% of the cases. However a small group of patients show a recurrence or persistence of the haematomas that are multiseptated. This shows that is necessary that they are treated in multiple occasions. We perform endoscopic treatment of recurrent chronic subdural haematomas.

Material and Method: We recruited all patients with a diagnosis of recurrent subdural haematoma, that were admitted from February 2006 to May 2008, who have been intervened previously to drain a subdural haematoma in different hospitals in the state of Oaxaca, with persistent data of hemiparesis and intracranial hypertension. All the patients were intervened via endoscopy, performing a micro craniotomy of 2 cm, through which, a rigid endoscope was inserted. Perforation of the membranes and communication to the subarachnoid space is performed, allowing the adequate drainage of the haematoma and avoiding its recurrence.

Results: A total of 26 patients were treated surgically via endoscopic lysis of the membranes. In 100% of the cases there was successful surgical removal of the haematoma. This generates a fast recovery in our patients who can leave the hospital soon after surgical intervention.

Considerations: The fenestration of recurrent membranes ensures an adequate resolution of the recurrent subdural haematoma after conventional drainage. We consider that endoscopy avoids performing a craniotomy for a resection, therefore reducing hospitalization time and the surgical risk for our patients.

Endoscopic biopsy and resection of intraparenchymal brain lesions

L.C. Alencastro, L.F. Alencastro, A. Lodetti, C. Martins, M. Faria (Porto Alegre and Recife, Brazil)

Introduction: New techniques and surgical tools have recently widened the possibilities of application of endoscopy in the treatment of intraparenchymal brain lesions. Target definition and route of approach are the mainstay of these surgical procedures, with conventional stereotaxy or neuronavigation being very helpful. The objective of this study is to demonstrate the technique of endoscopic approach of intraparenchymal lesions and to discuss the possibilities of this technique.

Material and Methods: Fifty six patients with intraparenchymal lesions were operated through this technique. The image guided endoscopic approach was performed to tissue biopsies or total resection of parenchymal lesions. The lesions included primary brain tumours, metastatic lesions, haematomas and cerebellar infarction. Multi-diameter sheaths were used to conduct the endoscope to the lesion, creating a cavity through the parenchyma, allowing direct vision of the lesion in some cases. In other cases, dissecting tools were attached to the endoscope, creating the concept of 'instruments that see'.

Results: Positive samples were possible in all biopsy cases. Total or subtotal resection was achieved as well in patients where lesion removal was aimed. These approaches proved to be very precise in placing the instruments in contact with the lesions, favouring easy and dynamic microsurgical technique. Direct vision enables the surgeon to choose the tissue sample to be resected in different

sites, favours effective bleeding control and enables sharp dissection of these lesions through less aggressive manipulation of brain parenchyma. A 12 mm craniectomy was performed in most of these cases. No morbidity was related to the method.

Conclusion: The direct vision with very good illumination and control of the operation field is possible through this endoscopic technique, resulting in effective procedures with no additional morbidity. Easier bleeding control is also a key advantage of these techniques.

The adjuvant role of neuroendoscopy in the management of brain tumours

L. Massimi, G. Tamburini, B. Pettorini, M. Caldarelli, C. Di Rocco (Rome, Italy)

Aims: To evaluate the role of transventricular neuroendoscopy in the management of different aspects of brain tumours, and to assess the effectiveness of a personal technique to perform biopsies in the posterior third of the third ventricle.

Material and Method: From 2003 to 2008, 126 patients (110 children, 16 adults) underwent neuroendoscopy to manage problems associated to cerebral tumours. The present paper mainly focuses on the 34 patients (25 children, 9 adults) who received procedures different from ETV or excision of colloid cysts. Overall, 41 endoscopic procedures were carried out in this subset of patients (6 of them had more than one operation at the same time): 13 septostomies, 14 tumoral cyst marsupializations, and 14 biopsies. Tumour biopsy was realized through a single burr hole approach and coagulation of the ipsilateral choroids plexus to eliminate a possible source of bleeding.

Results: Septostomy was effective in all the cases allowing either to avoid VP shunt or to place a single shunt instead of a bi-ventricular one. A child showed late closure of the stoma because of progressive growth of an optic-hypothalamic glioma, thus requiring craniotomy. Three failures were recorded among marsupializations due to the recurrence of the tumoral cyst: in one case (germ cell tumour) a redo endoscopy was possible, while the other 2 patients (craniopharyngioma and optic pathway glioma) needed craniotomy because of the enlargement of the solid portion of the tumour too. The tumour biopsy permitted the histological diagnosis in all the cases (6 astrocytomas, 5 germ cell tumours, 1 lymphoma, 1 pinealoblastoma, 1 metastasis from medulloblastoma). No major complications occurred. Minor bleedings were easily stopped with irrigation, only one patient requiring transient external drainage. Choroid plexus coagulation resulted very useful to prevent bleeding making safe the single burr hole approach to the posterior third ventricle.

Conclusions: This experience confirms the effectiveness and safety of neuroendoscopy in the management of brain tumours, regardless the age of the patients. A simple device can enhance the mini-invasiveness of the technique.

Posters

1. Low grade glioma imitating a pineal cyst

Y. Mondorf, M.R. Gaab, J. Oertel (Hannover and Mainz, Germany)

2. Endoscope-assisted decompression of the foramen magnum to treat Chiari I malformation

S-B. Gui, X-S. Wang, P. Zhao, X-Y. Zong, S. Kang, Y-z. Zhang (Beijing, China)

3. Technique and results of endoscopic endonasal surgery for pituitary adenomas

P. Kalinin, D. Fomichev, B. Kadashev, M. Kutin, R. Faizullaev, S. Alekseev (Moscow, Russia)

4. Escape from shunt system placed more than 20 years

T. Akai, S. Shiraga, K. Okamoto, H. Iizuka (Ishikawa, Japan)

5. Management of brain metastasis with complete endoscopic approach: 3 case reports

W-C. Hong, Y-D. Zeng, K-C. Chen, Y-S. Chen, L-T. Guo, S-J. Huang (Taipei, Taiwan)

6. Endoscopic treatment for multifactorial hydrocephalus

O. Garcia-Gonzalez, A. Marhx-Bracho, J.L. Perez-Gomez (Mexico, Mexico)

7. Treatment of suprasellar arachnoid cyst with endoscopic ventriculo-cisternostomy. An outcome analysis

J.A.J. Velez (City San Juan de los Morros, Venezuela)

8. Chordoid glioma of the third ventricle. Case report

C.E. Gagliardi, L. M. Cuello, P.Z. Maggiora, S. Cozzi, F. Torchiari, V. Herrero Ducloux, M. Bolla, M. Maldonado, C. Bustos (La Plata, Argentina)

9. Endoscopic drainage for chronic subdural haematoma associated with arachnoid cyst

Y. Ueda, T. Kawano, S. Yano, J-I. Kuratsu (Kumamoto, Japan)

10. Neuroendoscopic partial resection of pineal teratoma using videoscope: a case report and review of the literature

M. Kudo, S. Yano, T. Kawano, T. Hide, H. Nakamura, J. Kuratsu (Kumamoto, Japan)

11. Oculomotor nerve: Microanatomic and MRI relationship with the floor of the third ventricle

E. Buelens, F. Van Calenbergh, J. van Loon, G. Wilms (Leuven, Belgium)

12. Endoscopic transphenoidal repair of unusual cerebrospinal fluid leakage; report of two cases

Y. Hayashi, M. Iwato, K. Miyashita, Y. Hayashi, J-I. Hamada (Kanazawa, Japan)

13. Clinical and neuronavigational assessment of the single burr hole approach for ETV and posterior third ventricle surgery using rigid endoscopes

A. Bussarsky, V. Bussarsky, M. Marinov, K. Romansky (Sofia, Bulgaria)

14. Videoscope-controlled resection of posterior fossa epidermoid cyst

T. Kawano, S. Yano, K. Makino, J. Kuratsu (Kumamoto, Japan)

- 15. Endoscope-assisted microsurgical removal of a mesencephalic cysticercal cyst**
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- 17. Endoscopic endonasal transphenoidal surgery for pituitary adenomas: experience with 78 patients**
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