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Endoscopy in Intracranial Pathology

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1. Introduction

The use of endoscopy in intracranial pathology may be divided into two main subsets of procedures. The first subset entails the use of the endoscope in the management and treatment of intracranial intra-ventricular pathologies such as hydrocephalus, arachnoid cysts, and intra-ventricular tumors. The second includes trans-nasal and sinus endoscopy to manage mostly pituitary tumors, and other skull base pathologies, in addition to endoscope assisted microsurgery. This chapter, thus, will be divided into two parts to shed light on these two main endoscopic techniques used in intracranial pathologies.

2. Intracranial intra-ventricular Endoscopy

The first part of this chapter on Endoscopy for Intracranial Pathology will focus mainly on intracranial intra-ventricular neuroendoscopy. As the brain is a solid organ, neuroendoscopy is mostly limited to intra-ventricular endoscopy in the cerebrospinal fluid filled ventricular cavities. This is particularly facilitated in the setting of dilated ventricles or hydrocephalus. Obstructive hydrocephalus is actually one of the most common indications for endoscopic management in modern neurosurgical practice. In addition to management of hydrocephalus, a variety of intra-ventricular and other deep seated intracranial lesions may be approached endoscopically.

2.1 History

Endoscopic management of hydrocephalus was attempted as early as 1910 when VL L'Espinasse, a urologist, used the cystoscope to cauterize the choroid plexus (Hellwig et al, 2005). Dandy later refined this method and coined the terms ventriculoscope and ventriculoscopy for the instrument and technique. Mixter then, in 1923, performed the first successful endoscopic third ventriculostomy (ETV), and proposed ETV as a treatment option in occlusive hydrocephalus. Putnam later, in 1934 and then Scarff in 1936 reported on their series of patients treated with endoscopic coagulation of the choroid plexus using the special coagulation-endoscope. The mortality and morbidity of the choroid plexus coagulation procedures was high, and with the introduction of valved shunts in 1949, endoscopic management of hydrocephalus fell out of favor. With improved optics over the past two decades, and since the use of valved shunts is fraught with several known complications, endoscopic management of hydrocephalus regained intense interest.

2.2 Endoscopic third ventriculostomy for hydrocephalus

Endoscopic third ventriculostomy (ETV) is emerging now as one of the preferred treatment modalities for obstructive hydrocephalus (Schroeder & Niendorf, 2002) .The conventional ventriculostomy is simply a ventriculo-subarachnoidal shunt through a minimally invasive endoscopic approach with excellent endoscopic exposure and handling. The progress in magnetic resonance imaging (MRI) and Cine–Phase Contrast MRI in particular offers a reliable method for pre- and post-operative assessment of the patients (Fukuhara et al, 1999; Schroeder et al, 2000).

The surgical technique entails entering the foramen of Monroe after cannulating the lateral ventricle via a coronal burr hole and then after inspecting the floor of the third ventricle, perforating the floor with a blunt stylet or instrument and enlarging the perforation using a fogarthy balloon catheter or the endoscopic forceps. Inspection of the pre-pontine cistern is then performed and obstructing membranes may be similarly opened. A rigid neuroendoscope is usually placed through the burr hole performed approximately 2-3 cm lateral to the midline and just anterior to the coronal suture. Although flexible fiberscopes have been used for ETV, they offer a considerably inferior image quality and there is usually difficulty with their orientation, guidance, and fixation (Kamikawa et al, 2001). Before surgery, the relationship between the floor of the third ventricle and the tip of basilar artery is carefully evaluated on the sagittal MRI to reduce the risk of injury to the basilar artery (Wilcock et al, 1997).

ETV is considered a simple, fast, and safe procedure (Schroeder et al, 2002). Obstructive hydrocephalus represents the most important indication for ETV (Jones et al, 1994). Shunt independence, is the ultimate measure of the successful outcome of ETV. ETV for obstructive hydrocephalus has a failure rate of 20–40% in various series (Siomin et al, 2002). The failure rate, however, is markedly reduced, if certain selection criteria are taken into consideration, and these include obstructive hydrocephalus, age more than one year, history free of meningitis and subarachnoid hemorrhage, normal ventricular anatomy, tectal gliomas, posterior fossa tumors, and pineal region tumors (Bargallò et al, 2005; Li et al, 2005; O Brien et al, 2006; Oi et al, 2001; Pople et al, 2001; Sainte-Rose et al, 2001; Wellons et al, 2002).

Patients with obstructive hydrocephalus secondary to idiopathic aqueductal stenosis, tectal gliomas, and third or fourth ventricular tumors seem to have the best outcome after ETV (figure 1a&b) Communicating hydrocephalus secondary to meningitis or intra-ventricular or subarachnoid hemorrhage is associated with a higher failure rate (Siomin et al, 2002). Age seems also to be a very important factor, where infants less than 1 year of age have a higher failure rate, and in some series, under 6 months in particular. Studies have demonstrated a gradual decrease in ventricle size over months to years postoperatively, coinciding with clinical improvement (Buxton et al, 2002). The size of the ventricles is not a good predictor to use in the evaluation of the outcome within three months of surgery (Feng et al, 2004). In the early postoperative period, a decrease in the size of the ventricles is often minimal and not visible before three to four weeks. Cine-phase contrast MRI may be used to determine the patency of the stoma and may be used in follow up and has been demonstrated to correlate with patency of the stoma intraoperatively, where minor flow appears to be an early sign of closure (Fukuhara et al, 1999).

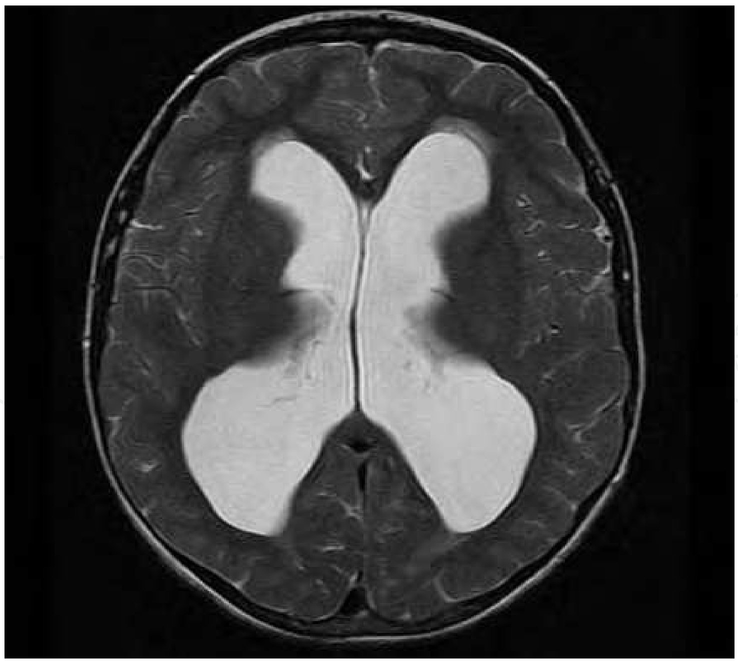

Fig. 1. a. Axial T2W MRI sequence demonstrating hydrocephalus secondary to tectal glioma. The child underwent endoscopic 3rd ventriculostomy with good outcome.

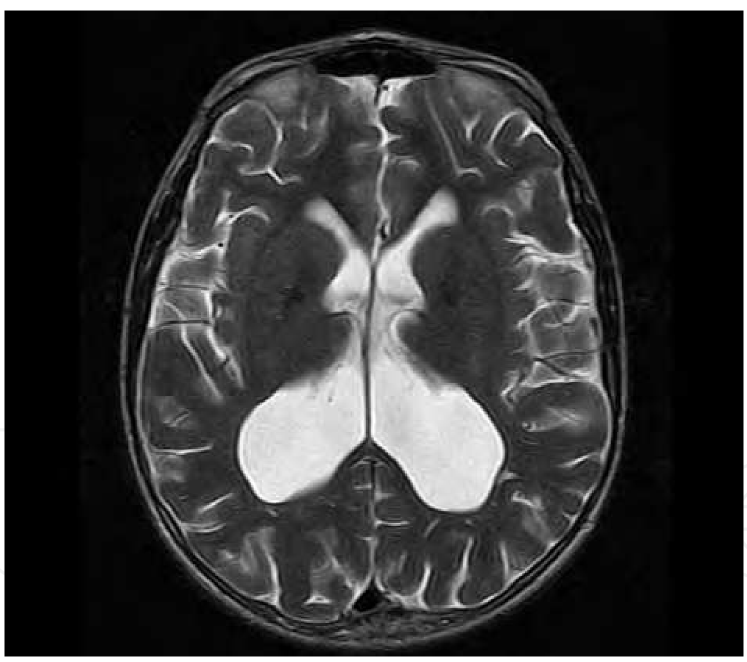

Fig. 1. b. Post operative axial T2W MRI sequence one year after surgery showing reduced ventricular size compared to the pre-operative examination.

A complication rate range of 0-20% is reported (Schroeder et al, 2002). The most serious complication of ETV is the injury to the basilar artery. The correct fenestration site is crucial for ETV success, which is recommended to be halfway between the infundibular recess and the mammillary bodies in the midline, just behind the dorsum sellae. Other complications reported are subdural hygroma (figure 2), CSF leakage, ventriculitis, diabetes incipidus, and third cranial nerve injury (Buxton et al, 2002; Fukuhara et al, 1999; Sainte-Rose et al, 2001). In one series of 193 ETVs done in 188 patients, permanent morbidities occurred in 1.6%, and 7.8% had transient morbidities (Schroeder et al, 2002). There were two deaths (1%). It was noted that during the course of the study, the complication rate dropped significantly, and no deaths or permanent morbidities occurred in the last 100 patients. In our unpublished series of 42 ETV procedures done for various causes of hydrocephalus, we had no procedure related complications, other than stoma occlusion in 4 of the patients necessitating ventriculo-peritoneal shunting. When done by an experienced endoscopist, and for the proper indications, we feel that ETV has a high success rate with a minimal chance of complications.

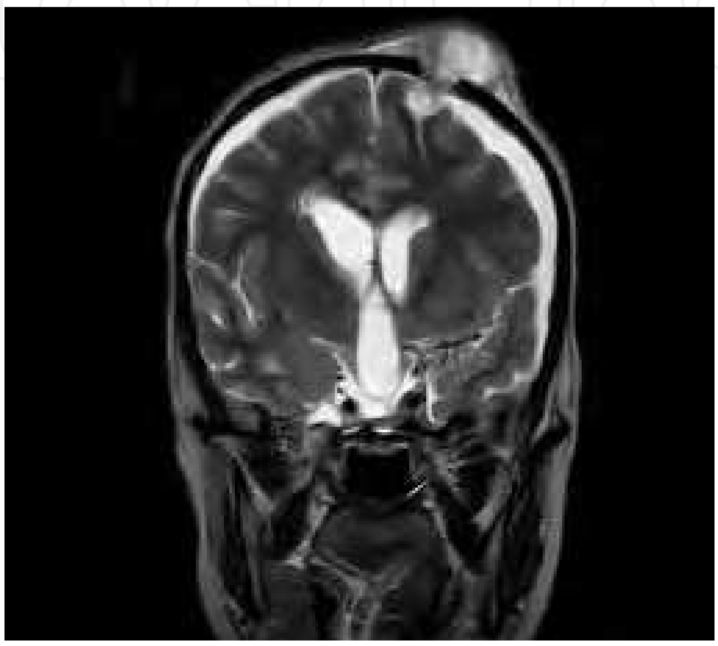

Fig. 2. Coronal T2W MRI sequence showing bilateral subdural hygromas and subcutaneous collection post endoscopic 3rd ventriculostomy for hydrocephalus. The stoma later blocked and a shunt was placed.

Whereas endoscopic 3rd ventriculostomy has a definite role in the management of 3rd ventricular, pineal region, thalamic, and tectal lesions, allowing simultaneous treatment of hydrocephalus and biopsy of the lesion, the role of ETV as a routine preoperative measure to treat hydrocephalus in posterior fossa tumors is less defined. In one study where patients with hydrocephalus and posterior fossa tumors either received ETV before resective surgery or conventional management, ETV dropped the need for a shunt from 20% to 6% (Sainte-Rose et al, 2001). Other authors confirm that ETV is an efficient procedure for controlling hydrocephalus associated with posterior fossa tumors, but find that the low rate of persistent hydrocephalus after tumor removal (9-12%) does not justify adopting routine preoperative third ventriculostomies (Fritsch et al, 2005; Morelli et al, 2005). Despite being successful, the two ETV procedures done before microsurgical resection in our previously reported series do not provide sufficient evidence to support performing ETV as a routine preoperative procedure (Najjar et al, 2010).

2.3 Endoscopic management of intra-ventricular lesions

Intra-ventricular lesions are often deep seated intra-cranial pathologies that pose a diagnostic and therapeutic challenge. They are often associated with hydrocephalus, and dealt with via stereotactic or open biopsies along with a CSF diversion procedure such as ventriculo-peritoneal shunting. Endoscopy is quickly rising as a minimally invasive technique that is extremely helpful in the management of certain intraventricular lesions thru the ability to get pathological tissue diagnosis, CSF markers, and treat the accompanying hydrocephalus, all in the same procedure. As just mentioned, these patients often undergo at least 2 different procedures such as stereotactic biopsies, shunts, and even bilateral shunts. The endoscopic procedure may be the only procedure needed in many of these patients who harbor chemosensitive or radiosensitive tumors that do not need further removal surgery. In others, endoscopic resection of cystic or small intraventricular lesions may be the definitive surgical management.

Endoscopic tumor management was successful in up to 96% of the cases in one series where 23 out of 24 biopsies and 2 out of 2 resections were successful (Souweidane 2005). In another series of 34 patients with pineal region tumors, histological diagnosis was obtained in 94% of the cases (Pople et al, 2001). Definitive treatment was then designed for each tumor according to the diagnosis. In our reported series, 8 out of 9 endoscopic biopsies were successful (89%), and the procedure was definitive in all the patients, where none required additional surgery (Najjar et al, 2010). Neuroendoscopic procedures, thus, have a great advantage in chemo- or radiosensitive tumors, such as germinomas, pineoblastomas, and primitive neuroectodermal tumors and are the preferential management option in most pineal region and posterior third ventricular tumors, since they guide further management whether microsurgical resection or other non-surgical therapies (Gangemi et al, 2001).

Some tumors may, on the other hand, be treated observantly. Certain thalamic gliomas that are beyond surgical resection may be observed, and others may be irradiated, depending on the grade of the tumor (Selvapandian 2006). An endoscopic biopsy, along with 3rd ventriculostomy to treat associated hydrocephalus, may easily attain the diagnosis (figure 3). A biopsy is not even necessary in tectal gliomas, since these lesions are usually indolent and the mere treatment of hydrocephalus and endoscopic inspection of the benign mass are enough according to several authors (Li et al, 2005; Ternier et al, 2006; Wellons et al, 2002). We had 4 patients with small tectal lesions who were successfully treated with endoscopic 3rd ventriculostomy, and had stable tumors and patent ventriculostomies through out the follow up period (Najjar et al, 2010).

Fig. 3. Coronal T1W MRI sequence showing a small left thalamic lesion with hydrocephalus. The child underwent endoscopic 3rd ventriculostomy and biopsy. Symptomatic hydrocephalus was thus treated and the low grade tumor proven at biopsy was stable and followed with imaging.

Colloid cysts, simple pineal cysts, and small intraventricular tumors may be removed or debulked endoscopically. Colloid cyst endoscopic surgery is described widely in the literature and is becoming a popular surgical technique in the management of these lesions (Grondin et al, 2007; Horn et al, 2007; Schroeder & Gaab 2002). Navigation assisted endoscopy may be needed in some of these patients, especially when there is no accompanying hydrocephalus (Souweidane 2005). Navigation could be also of great value in colloid cyst surgery, especially in selecting the entry point necessary for the optimal working angle (Schroeder & Gaab 2002).

Intra-ventricular arachnoid cysts such as suprasellar cysts and quadrigeminal plate cysts are optimal targets for endoscopic surgical management (Greenfield 2005). The cyst is usually fenestrated at two points to communicate it with the ventricular system and the adjacent arachnoid cisterns (ventriculo-cysternal and cysto-arachnoid communication). The success rate is quite high, and the simple procedure helps avoid implanatation of a permanent cysto-peritoneal shunting device in most patients. The more common temporal extraparenchymal arachnoid cysts, however, pose a more difficult endoscopic task. The anatomy is often more difficult and the fenestration site is close to critical structures. These temporal cysts may also be managed by microsurgical removal and/ or cysto-peritoneal shuting with similar results, and there is no consensus on their management (Tamburrini 2007).

Most patients with intraventricular lesions have associated symptomatic hydrocephalus. As mentioned earlier, endoscopic 3rd ventriculostomy (ETV) has a high success rate in tumor related obstructive hydrocephalus with long term patency ranging from 70-90%, and minimal complications. The ventriculostomy is usually done through the standard frontal burr hole, which may be adjusted to a more anterior position so the biopsy procedure can be done concomitantly (O'Brien 2006). Other authors advocate a 2 burr hole technique for optimal results, but we have found a single burr hole sufficient to perform the 3rd ventriculostomy and access most lesions in the 3rd and lateral ventricles to get a biopsy or perform a resection or debulking procedure. We also prefer to perform the ETV first, as preferred by most authorities, to avoid obscuring the operative field with blood-stained CSF after the biopsy. Smaller ventricles, presence of void signal on sagittal T2W MRI images, and presence of flow on cine-phase-contrast MR flow imaging, are helpful indicators of ventriculostomy patency, and when absent, close follow up is advised depending on the clinical condition (figure 4).

2.4 Conclusion

In summary, intra-ventricular neuroendoscopic techniques have rapidly become invaluable in the management of intra-ventricular brain lesions and hydrocephalus. In experienced hands, and after careful planning, biopsies can be taken safely, and adequately, outlining further management, especially in chemo and/or radio sensitive tumors. Other lesions may be resected, or debulked, and some may be observed. Cystic lesions, such as arachnoid cysts, may be resected or fenestrated, and the accompanying hydrocephalus is often treated in the same procedure, either with 3rd ventriculostomy, or with shunting after fenestration of the septum pellucidum in patients with large 3rd ventricular lesions. Thus, endoscopic procedures provide a minimally invasive approach to these pathologies, and might overcome complications that are usually associated with the conventional therapeutic strategies. These endoscopic procedures have simply become an indispensable part of our neurosurgical armamentarium available for the management of intra-ventricular pathologies.

Fig. 4. Post-operative cine-phase contrast MR flow study for the child shown in figure 2 demonstrating good flow of CSF at the level of the ventriculostomy (central white signal).

3. Endoscopic endonasal transsphenoidal & extended skull base approaches

The second part of this chapter deals with endoscopic skull base approaches, with special emphasis on their most common application: the endoscopic transphenoidal approach to sellar and pituitary tumors. This surgery has continuously evolved in the past century, and its history is a complex tale of development of innovative ideas coupled with periods of extensive surgical experimentation, striving to attain the best surgical results with minimal morbidity.

3.1 Historical perspective

The pituitary tumor resection performed by Canton and Paul, and via a temporal approach as advised by Homsley in 1893, is often sited as the first transcranial approach to pituitary tumors. Soon after, and in 1907, Schloffer attempted the first transsphenoidal surgery (Schloffer 1907). During that period, multiple variations of the inferior transnasal exposure were developed, and among the most popular were Cushing's sublabial route, and Hirsch's transnasal approach (Hirsch 1910). These approaches, however, and especially the latter, were sometimes extensive, and suffered significant technical difficulties, especially in the field of illumination. In 1956, Dott, and later Guiot, revived the interest in transsphenoidal pituitary surgery, and established its basic techniques. It was only till Hardy introduced the operating microscope in 1965, however, that the procedure gained wide acceptance, and became the work horse of pituitary surgery (Gandhi et al, 2009).
Variations of the sublabial transsphenoidal technique were then developed, with transnasal transseptal route, and other approaches aiming at a deeper mucosal incision to avoid nasal and dental complications. Despite the marked improvement in stereoscopic visualization

afforded by microscopic surgery, deeper incisions were difficult to perform because of the narrow surgical field. In 1977, Apuzzo described the use of the endoscope as an adjunct to the microscope in tumors with extrasellar extension, to afford better visual control around the corners, and to help obtain a panoramic view in the depth of the field (Appuzo et al, 1997). This was an essential step in the development of the extended transsphenoidal approach, expanding the boundaries of the surgical field to include lesions extending to the cribriform plate anteriorly, the cavernous sinuses laterally, and the clivus and foramen magnum inferiorly.

The pure endoscopic technique was described in the 1990s, first by Jankowski in 1992, and then three years later by Jho and Carrau who are regarded as the pioneers of the pure endoscopic endonasal approach (Jho & Carrau, 1997). In 1998, Cappabianca introduced the term functional endoscopic pituitary surgery (Cappabianca et al, 1999). The advantages of the pure endoscopic technique include the reduction of nasal complications, better visualization of the blind corners with angled telescopes, and the ability to change perspectives between close-up and panoramic views. The endoscopic technique has since spread and is being practiced in many centers around the world.

3.2 Endoscopic endonasal approaches: Technical considerations

The endoscopic endonasal transphenoidal approach can be divided into 3 phases: the nasal phase, the sphenoidal phase, and the sellar phase. In the nasal stage, the rigid endoscope is introduced along the floor of the nasal cavity reaching the choana which is a fundamental finding in this phase. Its medial aspect represents the vomer which confirms the midline of the approach, while its roof takes the shape of the sphenoid sinus's floor. Proceeding with the endoscope in a superior direction, the middle turbinate is encountered and dislocated laterally to ensure an adequate surgical pathway. Then, the endoscope can be angled along the spheno-ethmoid recess reaching the sphenoid ostium . This heralds the beginning of the next phase; the sphenoidal phase. After identifying the sphenoid ostium , the mucosa covering the ethmoid recess has to be cauterized to reduce possible annoying bleeding from the septal branches, exposing the whole anterior wall of the sphenoid sinus . The ostium is enlarged completing the anterior sphenoidectomy step (figure 5). Reviewing the anatomy of the sphenoid sinus septae on the pre-op CT scan helps understanding the sellar floor and the medial extent of the cavernous sinus. Preservation of the sphenoidal mucosa is important to ensure an adequate muco-ciliar transport which plays a major role in the physiology of the naso-sinusal ventilation (Kalushar 1997). Moreover, the proximity of the internal carotid artery (ICA) and the sphenoid sinus must be considered while removing the sphenoid sinus mucosa as the bone covering its anterior loop might be missing in 4-8% (Fujii et al 1979). Now, the posterior wall of the sphenoid sinus with the sellar floor at its center is recognizable and we can fix the endoscope to its holder freeing the surgeon hands for the next step (figure 6). The sellar phase starts with opening of the sellar floor by means of microdrill or a kerrison's rongeur depending on its consistency and it may be extended as required by the specific pathology reaching the sphenoid planum above, the anterior limit of the cavernous sinus on the side or the clivus inferiorly. Then, the dura is incised and care should be applied not to reach the perisellar sinus or the ICA itself. Before removing the adenoma, the pituitary gland should be identified and preserved. Removal of macroadenomas should be performed sequentially starting laterally to avoid premature delivery of the redundant diaphragm into the operating field. After emptying the intrasellar adenoma, an angled endoscope may be advanced for a better inspection of the supra and retrosellar compartments.

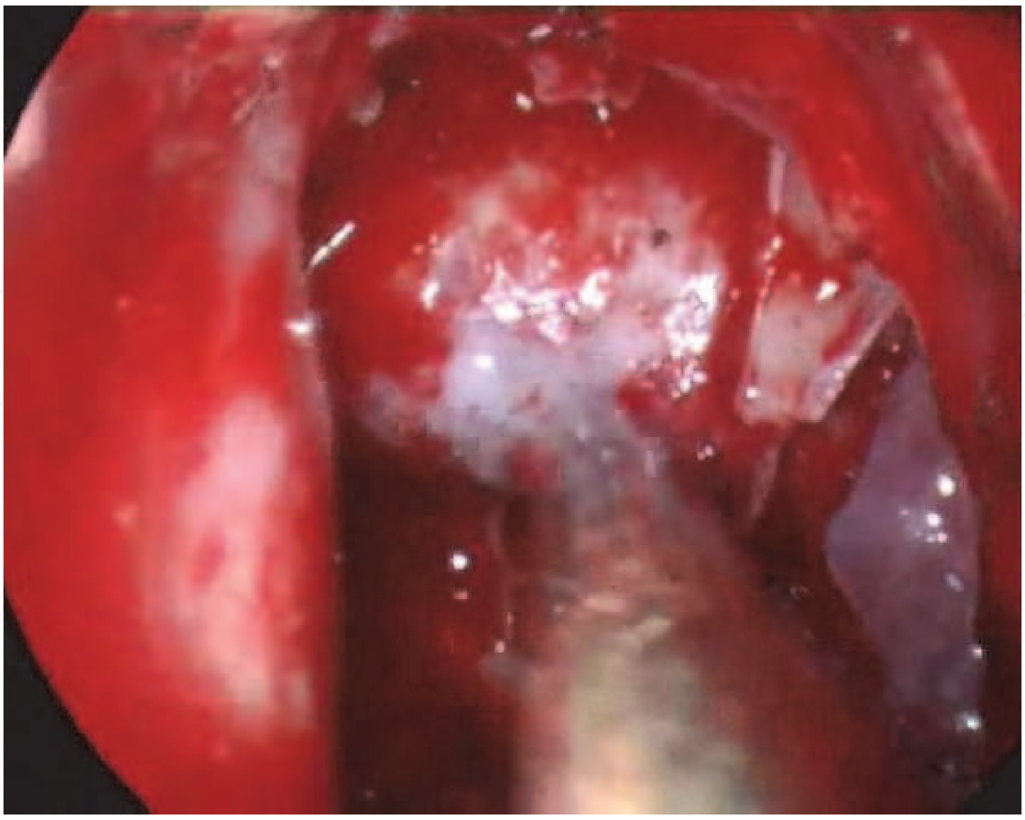

Fig. 5. Endoscopic view of the sellar floor during the sphenoidal phase

Fig. 6. Use of the endoscope holder in endoscopic transsphenoidal surgery for pituitary adenomas

A variation of the technique described above entails using both nostrils and the dynamic process of the two surgeons working together without the endoscope holder (2 nostril, 4 hand technique). Although many centers have moved towards adopting this more dynamic technique, we feel that it entails more aggressive work in the nose, often not needed in the soft, easy to remove pituitary adenomas. This technique becomes necessary, however, for more extensive skull base pathology. With the recent revolution of skull base surgery, the endoscope is increasingly used for attacking skull base lesions from below. The same rules of endoscopic endonasal transphenoidal approach may be applied but in an extended fashion to treat a wide variety of pathologies involving the cribriform plate, the planum sphenoidale , the cavernous sinus, the sellar and parasellar compartments, the clivus, down to the foramen magnum and C2 level. The ethmoido-pterygo-sphenoidal approach allows a rapid, wide, extracerberal, and direct exposition of the skull base floor. Yet, CSF leak and the inability to cross nerves, represent major challenges that limit its widespread use. In a series of 16 craniopharyngiomas, Gardner reported high rates of preservation of endocrine function without sacrificing the extent of resection using the extended endoscopic approach (Gardner et al, 2008). A high rate of post-op CSF leak was noted (58%) though, highlighting the importance and complexity of skull base reconstruction in these patients.

3.3 Endoscopic endonasal surgery: Advantages

The main advantages of the endoscopic technique may be divided into nasal and neurological (Har-El 2005). In addition to an excellent view of the bony and soft tissues in the nose, the endoscopic approach helps avoid several complications commonly seen in the transseptal microscopic approach, such as perforation, septal deformity, saddle nose deformity, nasal obstruction, and long term epistaxis and crusting. It also helps avoid dental complications seen at times after the sublabial microscopic approach including hypoesthesia or anesthesia of the incisor teeth (Har-El 2005). Recovery from an otolaryngologic aspect of the surgery is often rapid, with no swelling or oral wounds that contribute to postoperative pain and discomfort. Normal food intake is immediate, and hospital stay is shorter.

The neurological advantages are mostly related to superior visualization in the intrasellar cavity, especially when the angled telescopes are used to look for residual tumor in the blind corners and suprasellar area. When judging any new surgical technique, it must be compared with the current gold standard on the most important key indicators: oncological and endocrine outcomes, re-operation rates, and complications. In a meta-analysis on over 800 pts from studies published prior to 2006, both safety and efficacy of the endoscopic approach was demonstrated with high rates of gross total removal of tumors and normalization of endocrine function with improved vision (Tabaee et al, 2009a). In another study, an angled endoscope was used to evaluate 40 patients who underwent a microscopic resection of a pituitary tumor (Helal 1995). A large percentage (40%) had residual tumor. The same result was reproduced by Jarrahy's assessment of the efficacy of endoscopy in pituitary adenoma resection (Jarrahy et al, 2000). Others authors, using a hybrid technique, have agreed that the endoscopic view is superior when compared to the microscopic view (Baussart et al, 2005). Dehdashti et al reported on the early surgical results in 200 patients who had the pure endoscopic endonasal approach for their pituitary adenomas and compared them with previous microsurgical series (Dehdashti et al, 2008). He found comparable rates of gross total resection at 98% for intrasellar tumors and 96% for tumors with suprasellar extention (figure 7a&b).

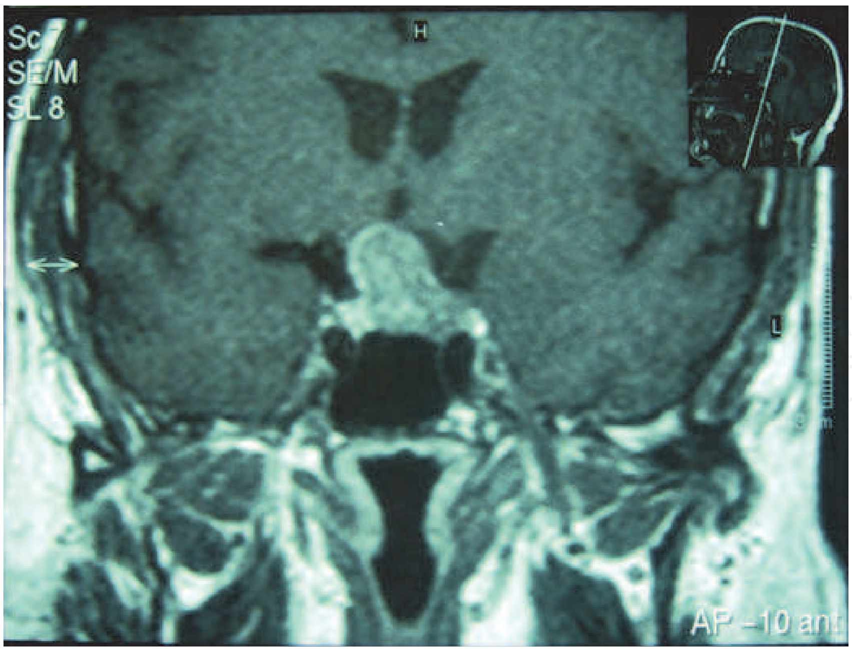

Fig. 7. a. Coronal T1W MRI sequence of the brain with gadolinium showing a large pituitary macroadenoma displacing the optic chiasm superiorly and the pituitary gland to the right side. The patient suffered visual field disturbances.

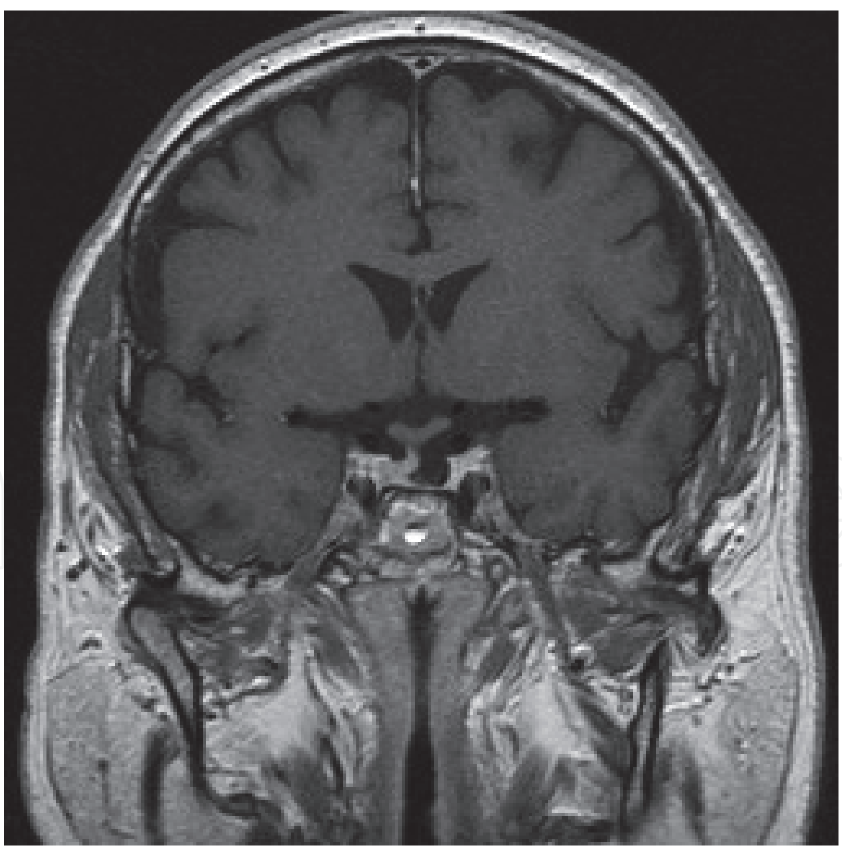

Fig. 7. b. Post-operative coronal T1W sequence of the brain with gadolinium for the same patient showing complete removal of the tumor. The patient's visual field defect resolved after surgery.

A multitude of studies support excellent endocrinologic outcomes following endoscopic surgery for secreting pituitary adenomas. D'Haens et al assessed 120 patients with functioning adenomas in a retrospective study (D'Haens et al, 2009). The remission rate of hypersecretion was significantly better in the endoscopic group (63 vs 50%). Kabil et al reported on 300 pts undergoing endoscopic resection with a similar cure rate of 87% in GH secreting adenomas, 86% in Cushing's disease and 80% in prolactinomas (Kabil et al, 2005). We have also noted a high cure rate in our endoscopic series of patients treated for Cushing's disease (figure 8a&b). A 90% biochemical cure in a purely endoscopic series of 21 patients was also reported in another series (Tabaee et al, 2009b). In patients with macroadenomas with visual field cuts, complete normalization of preoperative visual defect was noted in 50% of endoscopically approached tumors in one study, with an additional 39% having improvement (Dehdashti et al, 2008). Zhang et al achieved 70% recovery of preoperative visual defects in over 300 cases (Zhang et al, 2008). These reported rates of visual recovery in the endoscopic literature are slightly higher than those traditionally reported for microscopic approaches (Schaberg et al, 2010).
Length of stay has been shown to be decreased in multiple series (O'Malley et al, 2008). Patients were able to return home 2 days earlier on average (Higgins et al, 2008). We have had a similar experience in our patient series, where the average hospital stay was 2 or 3 days. In one review, the endoscopic group had a statistically significant reduction in their hospital stay: 3.4 vs 8.3 days (Neal et al, 2007). Similarly, a number of studies demonstrated an operative time that is significantly less on average by about 1hour (O'Malley et al, 2008).

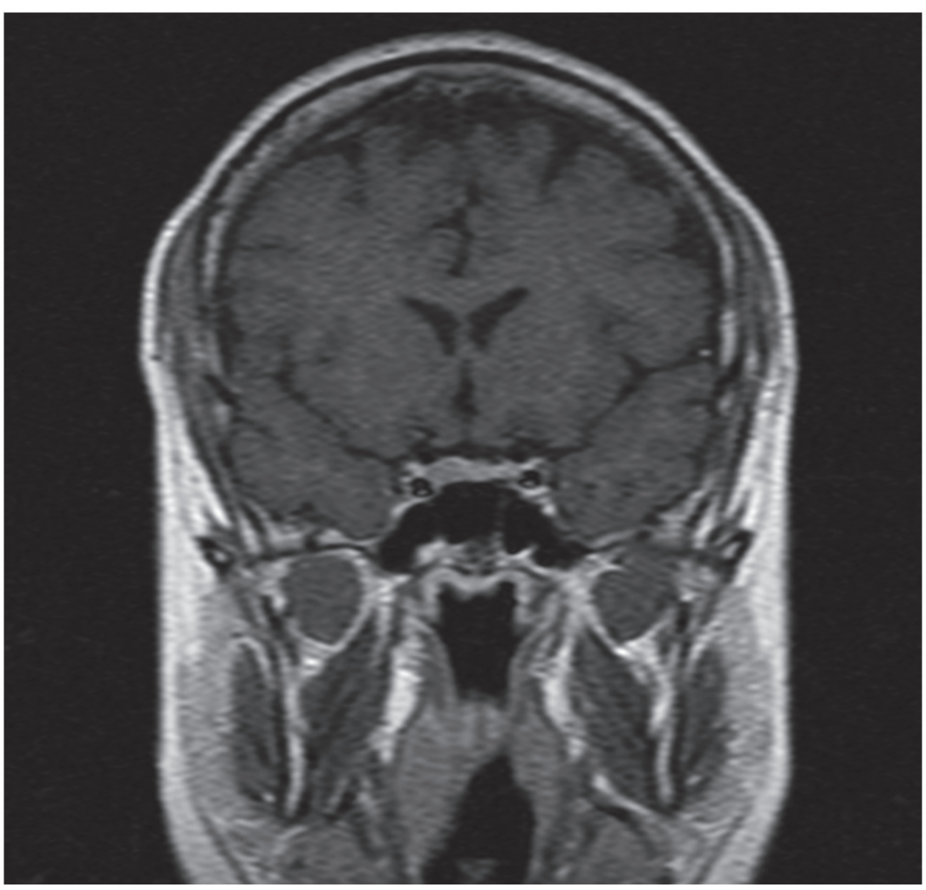

Fig. 8. a. Coronal T1W MRI sequence of the brain showing a hypointense lesion in the right sellar area indicating a pituitary microadenoma. The patient had Cushing's disease.

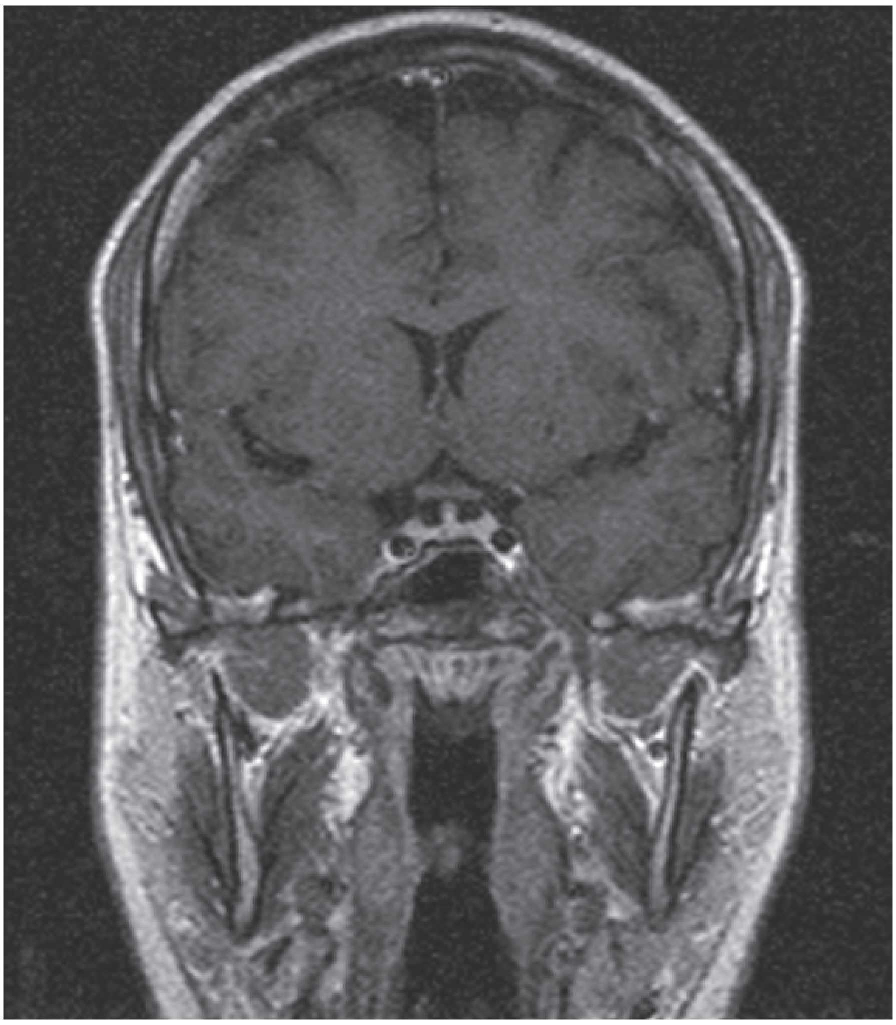

Fig. 8. b. Post-operative coronal T1W MRI sequence of the brain with gadolinium at 1 year after endoscopic removal of the adenoma indicating complete removal with no recurrence. The patient had endocrinological cure by blood testing as well.

3.4 Complications and disadvantages

The major complications, which are quite rare, are similar to those seen in the routine microscopic surgery and include CSF leak, vascular injuries, intracranial injury, endocrine abnormalities, meningitis, and death. The complications rates have been comparable between the two techniques. O'Malley et al reported on 50 pts, half of them undergoing microscopic approaches and half undergoing endoscopic approaches, and showed comparable complication rates between the two groups for both CSF leak and incidence of diabetes insipidis with a trend toward less diabetes incipidus (DI) in the endoscopic group (O'Malley et al, 2008) . Kabil et al demonstrated a 2% CSF leak in a series of over 650 patients undergoing endoscopic resection (Kabil et al, 2005). Minor complications include septal perforation, trauma to external nose and sinusitis. The nasal complications are much less in the endoscopic approach when compared to microsurgical sublabial approaches as mentioned earlier.

The development of a new surgical technique often begets criticism due to the possibility of a learning curve. In modern medicine, there is a distinct advantage to a multidisciplinary team approach with otolaryngologists and neurosurgeons working together in the surgical management of these cases. Another controversy is the lack of stereoscopic vision .Yet, novel 3D endoscopy provides stereoscopic view and may help overcome this obstacle. The next step in the evolution of endoscopic transphenoidal surgery is linked to ongoing work utilizing intra-operative magnetic resonance imaging and robotics, and to the miniaturization of the optical systems in terms of chip-stick technology, and the cooperation between different technologies and industries (Cappabianca et al, 2008).

3.5 Conclusion

In summary, the endoscopic techniques used in anterior skull base surgery have caused a revolution in the management of pituitary tumors and several other lesions in the anterior skull base and clival regions. The approach is minimally invasive, and affords excellent visualization of deep structures. The endoscopic technique is moving to be the standard technique for pituitary tumors and other sellar lesions. Patients have much less nasal complaints, and stay less in the hospital. Most authorities report superior visualization of small tumor remnants in the corners, usually blind in microscopic surgery. For more extensive lesions of the anterior skull base and clivus on the other hand, the significant CSF leak rate, though reduced with recent nasal flap techniques, and significant nasal side effects seen in the more extensive extended endoscopic approaches, have stalled their widespread acceptance. The technology is continuously evolving, however, and much is to be expected in a very exciting and rapidly evolving field.

Note: All the figures listed are original figures.

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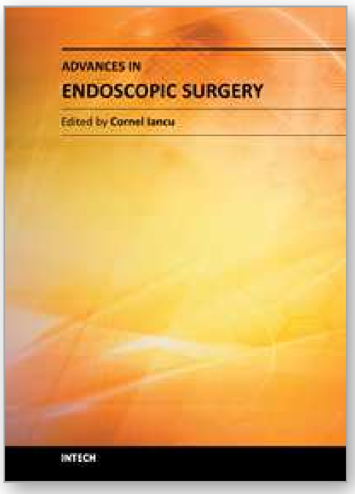

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Surgeons from various domains have become fascinated by endoscopy with its very low complications rates, high diagnostic yields and the possibility to perform a large variety of therapeutic procedures. Therefore during the last 30 years, the number and diversity of surgical endoscopic procedures has advanced with many new methods for both diagnoses and treatment, and these achievements are presented in this book. Contributing to the development of endoscopic surgery from all over the world, this is a modern, educational, and engrossing publication precisely presenting the most recent development in the field. New technologies are described in detail and all aspects of both standard and advanced endoscopic maneuvers applied in gastroenterology, urogynecology, otorhinolaryngology, pediatrics and neurology are presented. The intended audience for this book includes surgeons from various specialities, radiologists, internists, and subspecialists.