ORIGINAL ARTICLE

Endoscopic Transsphenoidal Pituitary Surgery: Local Experience

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Abstract

Background: The endoscopic transsphenoidal approach to pituitary tumors has become popular and accepted, with minimal postoperative morbidity.

Aim: To document the efficacy and the patients' safety of endoscopic transsphenoid surgery.

Patients and methods: Summary of 55 consecutive patients with pituitary tumors who underwent endoscopic transsphenoidal surgery at the Department of Neurosurgery, Ibn Sina Teaching Hospital from March 2018 to February 2021. Follow-up is between 6 months and 2 years.

Results: Females represent 52.7% and males 47.3% of the patients. Non-functioning tumors represent 32.7%, while hormones-secreting tumors are 67.7%. In 29 patients (52.7%), the tumors were completely excised. Subtotal excision was performed in seven patients (12.8%), while partial removal was done in 19 patients (34.5%).

Conclusion: Endoscopic transsphenoidal pituitary surgery is a safe approach to pituitary adenomas, avoiding external scars with minimal postoperative morbidity.

Keywords: Complications, Endoscopic pituitary surgery, Pituitary adenoma, Transsphenoidal

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Introduction

The earliest transsphenoidal surgery has been documented (1907–1909) by Schloffer, von Eiselsberg, and Kocher required external rhinotomy incisions. Since then, several pioneers such as Halstead, Hirsch, Cushing, and Hardy improved the technique to become more accurate with less trauma to the surrounding structures.[1,2] Jho and Carrau from the University of Pittsburgh Medical Center popularized the pure endoscopic transsphenoidal approach to sellar tumors in the late 1990s. This procedure offers a panoramic vision with the ability to see around the corners and has led to a less traumatic transsphenoidal approach and avoids the transsphenoid retractor's appliance.[3,4]

This procedure does not usually involve separating septal mucosal flaps; instead, it is performed totally endonasal, which is why the word "endonasal" is eliminated, and the procedure is called endoscopic trans-sphenoid pituitary surgery (ETPS).

Generally speaking, ETPS aims to eradicate the adenoma as entirely as possible and to normalize hormonal imbalance in functioning adenomas. At the same time, the pituitary function must not be endangered, and the pressure effect of the tumor should be relieved.[5–7]

Our study aimed to document the efficacy and the patients' safety of ETPS done for pituitary adenomas in a series of patients operated on at our center.

Patients and Methods

This is a case series summary of 55 consecutive patients with pituitary tumors who underwent endoscopic transsphenoidal surgery at the Department of Neurosurgery, Ibn Sina Teaching Hospital from March 2018 to February 2021. Patients were enlisted from the attendants of the outpatient clinic with a diagnosis of pituitary adenoma.

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The study was approved by the Medical Research Ethics Committee at the College of Medicine/ the University of Mosul, Iraq, with the approval code UOM/COM/MREC/20–21. Informed consent was obtained from patients willing to participate in the study. Follow-up period was between 6 months and 2 years.

Patients were examined by the neurosurgeon regarding cranial nerves function and general neurological assessment. The general appearance is noted as acromegaly, Cushing's disease, or thyrotoxicosis, and then the patient is then examined by the otolaryngologist for the condition of the nose and paranasal sinuses and any other conditions septal deviation which may make binostril surgery difficult.

Imaging included plain computed tomography (CT) of the paranasal sinuses in a bony algorithm and MRI with gadolinium of the sellar area. Both are requested in thin slices. MRI delineates the actual size and consistency of the tumor and its relation to optic nerves, cavernous sinus, and carotid arteries. CT is required to assess any abnormality in the nasal cavity as concha bullosa or

Onodi cells. The sphenoidal sinus represents the area of interest studied carefully regarding pneumatization and relation to the optic nerves and carotid arteries.

The biochemical analysis included a pituitary hormones assay. Acromegaly was diagnosed clinically and confirmed by a high growth hormone (GH) level, insulin-like growth factor I (IGF-I), and failure of GH suppression by oral glucose load. Prolactinoma was diagnosed clinically by features of hyperprolactinemia as galactorrhea and infertility in women and gynecomastia and impotence in men and established by serum prolactin level. Cushing's disease was also diagnosed clinically and proved by high serum cortisol and ACTH levels, lack of circadian rhythm for ACTH and cortisol, and increased free urinary cortisol. Non-functioning adenomas were diagnosed by the lack of clinical and biochemical evidence of increased hormonal secretion, except for prolactin which may be elevated due to the stalk effect.

An ophthalmologic evaluation was also performed when there was clinical or radiological evidence of optic nerve compression and included optic disc, visual field assessment, pupil's examination, and extraocular muscles.

Patients with low cortisol levels were prepared for surgery by administering methylprednisolone in two doses; on the previous day of surgery and on stress dose at the time of surgery. We gave thyroxine for low T3 and T4, and surgery was postponed until a normal or near normal level was achieved. All patients with prolactin-secreting adenoma were given cabergoline. For apoplexy cases, we start methylprednisolone.

Surgical Procedure

The endoscopic endonasal transsphenoidal approach was adopted in all cases. After general anesthesia and orotracheal intubation, the patient is placed supine with the head slightly flexed and supported on the head ring. As our otolaryngologist is right-handed and our neurosurgeon is left-handed, there is no interference during instrumentation, and the four hands work together comfortably. When the sella is entered, the patient's head is slightly turned toward the neurosurgeon to facilitate tumor removal.

A C-arm fluoroscopic device is then placed to provide a lateral view of the sphenoid sinus and the sella. In the first 10 cases, an intraoperative X-ray was obtained in every case. Later, when we became more confident and familiar with the field, intraoperative radiology was required in two cases only, where the field was difficult and bloody. After sterilization, the nasal cavities are packed with a diluted adrenaline cottonoids (1:100,000). Surgical procedure starts with an inspection of the inner nose with zero degree endoscope, then a unilateral nasoseptal (Hadad) flap is harvested. The bony nasal septum is removed with the rostrum, and both sphenoid sinuses are connected by removing the inter-sphenoid septum. For this purpose, different bone-cutting forceps and Kerrison Rongeurs are used. The sphenoid sinus is exposed from the planum to the sinus floor and laterally up to the lateral walls to see the carotid bony prominences. The nasal mucosa on the other side is simply cauterized posteriorly to allow the insertion of instruments from both sides (binostril work). In some cases, the middle turbinate is resected to facilitate the approach. In a few cases, when there is severe nasal septal deviation, a mononostril approach is adopted.

The sphenoid sinus mucosa is cauterized and peeled off the sellar bulge. The bony sella is removed piecemeal by a Kerrison Rongeurs or a micro drill. After that, the dura is incised in a cruciate manner. The tumor is now removed by different sizes and angles curettes with suctioning. Some tissue is sent for histopathological study.

Surgical closure of the defect depends on the size of the tumor and the presence or the risk of cerebrospinal fluid (CSF) leak. If the cavity is small and there is no CSF leak, a single layer closure by Hadad flap is performed. When there is a CSF leak, the cavity is plugged with appropriate autologous periumbilical fat, and then the flap is positioned over it. A third middle layer of fascia lata may be inserted in more extensive defects. Usually, tissue glue is applied over the edges of the flap to ensure stable healing. A vaseline nasal pack is inserted for 5 days. Intravenous Ceftriaxone is started at the induction of surgery and continued for 7 days or longer if there is evidence of infection. Analgesia included paracetamol and diclofenac injections. After the nasal pack is removed, the patient attends for regular debridement of nasal crusting and instructs for daily nasal irrigation with saline. Hormonal assay is repeated postoperatively, and any hormonal deficit is corrected accordingly.

Postoperative radiological assessment is done with MRI, 2–3 months after surgery, and radiological improvement is defined by total excision of the mass.

One month postoperatively, proper visual field testing was repeated for the patients having preoperative deficits.

Criteria for improvement: For non-functioning adenomas, it is a relief of pressure effect as improvement of vision. For functioning adenomas, it is the normalization of hormonal level and improvement of pressure effect if present.

The cure for apoplexy is the improvement of the level of consciousness, headache, and vision.

Results

Preoperative Variables of the Patients

Table 1 shows that the mean age of the patients is 35.38 ± 10.5 years, and the duration of symptoms is 55.5 months preoperation. Females represent 52.7% and males 47.3% of the patients. The tumors are categorized as non-functioning tumors representing 32.7%, and hormones-secreting tumors represent 67.7% of the patients, distributed as shown in Table 1.

Preoperative visual evaluation of our patients showed that 17 patients (30.9%) had normal vision. Bitemporal hemianopia was found in 24 patients (43.6%). Eleven patients (20%) had reduced monocular vision. Blindness was observed in three patients, monocular in one patient and binocular in the other two, as shown in Table 2.

Table 1: Preoperative variables of the patients

Age/years		Mean ± SD	35.5
Duration/months of pre-op. symptoms		Mean ± SD	55.48 ± 60.1
Gender		Male	26 (47.3%)
		Female	29 (52.7%)
Type of tumors	Non-functioning		18 (32.7%)
	Functioning (hormone-secreting)		43 (67.7%)

Tumor Types and their Excision

Most of the tumors are hard, representing 46.0%, the cystic and the soft tumors coming next at 25.0% and 20.0%, respectively, and lastly, the tumors of mixed consistency represent only 9.0%. According to size, macroadenoma constitutes 92.7%, while microadenoma represents 7.3%. Total tumor excision was achieved in 52.7% of the patients, 34.5% subtotal, and 12.8% partial removal.

Operative Techniques

In 92.7% of our cases, we operated through both nostrils. In four patients (7.3%), we operated through one nostril (mononostril approach) due to severe nasal septal deviation. Ten patients (18.2%) required excision of the middle turbinate on one side to continue with the binostril approach. For reconstruction of sella, we used fibrin glue, Hadad flap (HBF), and abdominal fat. They were used in 50 patients (90.1%), 43 (78.2%), and 38 (69.1%), respectively.

Postoperative Parameters

After surgery, patients with normal preoperative vision and those with preoperative blindness in one or both eyes had the same visual acuity, as shown in Table 2. Among patients with bitemporal hemianopia and reduced monocular vision, 19 patients from the first group and nine from the latter group showed clinically significant visual improvement. Patients with blindness had no significant improvement in vision.

In 29 patients (52.7%), the tumor was completely excised. Subtotal excision was performed in seven patients (12.8%), while partial removal was done in 19 patients (34.5%), as shown in Table 3. Postoperative radiation was required in two patients. One patient with acromegaly required redo-surgery due to incomplete removal of the tumor during the first surgery. One patient with ACTH secreting tumor died at induction of anesthesia before surgery. CSF leak and pneumocephalus each occurred in two patients (Table 4). Another two patients experienced hormonal deficits, and each occurs in 3.6% of patients. Diabetes insipidus appeared in 29 (52.7%) patients; 89.7% were temporary and 10.3% permanent. Olfactory changes occurred in 28 (50.9%) patients; 39.3% of them have transient anosmia, 10.7% permanent anosmia, 42.9% transient hyposmia, and 7.1% permanent hyposmia.

Discussion

To our knowledge, this is a novel experience in Mosul city, as this surgery has been recently introduced to the center and the city by the same two authors of this study.

The mean age of the patients is 35.38 ± 10.5 years. Males represented 47.3% of the patients, and females represented 52.7%. The mean duration of symptoms is 55.5 months. These results are close to Tumul et al.,[8] in which the median age of the patients was 38[12-19] years, with a preponderance of males in all categories. Eördögh et al.[8] reported 42 patients aged 18–77 years (mean age 50.3 years) with equal numbers of both sexes.

The tumors are categorized as non-functioning tumors, which represent 32.7%, and hormones-secreting tumors represent 67.7% which was distributed as shown in Table 1.

Total tumor excision was achieved in 52.7% of the patients, 34.5% subtotal, and 12.8% partial removal.

Preoperative visual evaluation is shown in Table 2. Fortunately, we didn't have any case of minor or significant injury to the optic nerve or tract, and no patient showed deterioration of vision after surgery. After surgery, patients with normal preoperative vision had the same visual acuity. Also, patients with blindness in one or both eyes didn't show any good change in vision as they had blindness

Table 2: Vision of the patients before and after surgery

Preoperative vision	*Number (%)*	*Postoperative vision and its details*
Normal	17	All patients have normal vision
Bitemporal hemianopia	24	19 hade improvement 5 no improvement
Monocular reduced vision	11	9 hade improvement 2 no improvement
Monocular blindness	1	No improvement
Binocular blindness	2	No improvement

Table 3: Postoperative parameters

Post-op parameters	*Presence and details*	*No. (%)*
Removal of tumor	Total	29 (52.7%)
	Subtotal	7 (12.8%)
	Partial	19 (34.5%)
Radiation	Gamma knife	2 (3.6%)
Redo surgery	Revision after 4 months	1 (1.8%) GH adenoma

Table 4: Postoperative complications

Type	*Details*		*Number (%)*
Mortality	ACTH-secreting		1 (1.8%)
CSF leak	Both non-functioning adenomas		2 (3.6%)
Pneumocephalus	One prolactinoma, two non-functioning		3 (5.5%)
Diabetes insipidus	29 (52.7%)	Temporary	26 (89.7%)
		Permanent	3 (10.3%)
Epistaxis	Severe, occurred after removal of pack		2 (3.6%)
Hormonal deficit	Both are non-functioning adenomas. Postoperative hypopituitarism		2 (3.6%)
Olfactory changes	28 (50.9%)	Anosmia	11 (39.3%)
		Permanent anosmia	3 (10.7%)
		Hyposmia	12 (42.9%)
		Permanent hyposmia	2 (7.1%)

for 5–10 years. However, improvement in vision was noticed in the rest of our patients; among patients with bitemporal hemianopia and reduced monocular vision, 19 patients from the first group and nine from the latter group showed clinically significant visual improvement. The estimated incidence of blindness after ETPS is 0.2–1.2%.[8-11] It was zero in our study.

In 92.7% of our patients, we utilized the binostril approach to the sella. We had to resect the middle turbinate in 18.2% of patients for better exposure, especially patients with acromegaly in whom the turbinates are very large. The mucosa of the resected middle turbinate is used for covering bare surfaces at the end of surgery. According to Friedman et al., partial removal of middle turbinate does not affect olfaction.[12] Radical turbinate removal can lead to crusting, bleeding, paradoxical breathing difficulty, and empty nose syndrome.[13,14] In patients with severe septal deviation, we adopted the mononostril approach (7.3%) rather than doing septoplasty at the time of pituitary surgery, as we believe that the redundant flaps of septoplasty interfere with the endoscopic work. Mononostril work is a well-documented technique to approach pituitary tumors. It was initially developed to overcome severe nasal septal deviation, then adopted by some surgeons to work in all cases avoiding the need to do posterior septectomy and preserving mucosa entirely on one side of the nose. However, this method has the disadvantage of limited exposure in narrow noses, and the surgeons work with three hands rather than the conventional four-handed technique. Eseonu et al. believe that the mononostril approach can significantly decrease the operative time while complication rates are not jeopardized.[15]

Many different reconstructive techniques with the application of various autologous and synthetic materials have been presented. Among all the known options, the vascularized pedicled nasoseptal flap seems to be the 'gold standard' flap. The first description of this flap was by Oscar Hirsch in 1952 for repairing the CSF leak.[16] In 2006, Hadad et al. described the Hadad-Bassagasteguy flap (HBF) in detail with its blood supply.[17] Multiple studies have indicated its efficacy in reconstructing skull base defects, with overall success rates of 94–99%.[18-20] In our study, we used HBF in 43 patients (78.2%), which successfully prevented CSF leak in all of them. Fibrin glue is used to seal the edges of the flap. It was required in 50 patients (90.1%). When the surgical defect is significant, it is obliterated by fat, which was used in 38 (69.1%).

Complications in patients undergoing ETPS are rare but essential to anticipate. The reported postoperative mortality rate is low, 0.4–2.0%.[21-23] One patient with an ACTH-secreting tumor in our series died at induction of anesthesia before surgery due to a cardiac standstill.

Cerebrospinal fluid leak happens when the diaphragm sella is validated by the tumor or the surgeon. Postoperative changes in intracranial pressure could cause the CSF leak in some instances. Two key points are vital to avoid this complication: the mass located at 12 o'clock direction is removed at the end, and the surgical defect should be closed with one of the artificial materials available. Postoperative CSF leak was reported to occur in 0.9–6%.[3,6,9,11] CSF leaks occurred in two patients (3.6%) among 55 enrolled in our study; both manifested as meningitis. One of them was prolactinoma which was reconstructed initially by autologous fat. She responded well to conservative treatment, and the leak stopped spontaneously. The other was a non-functioning tumor which was also closed initially by fat. He required revision surgery with a muscle graft for closure of the defect. The incidence of CSF leak in our series is comparable to other series.[6,21,24]

Pneumocephalus is a life-threatening emergency that, if not treated quickly, may have catastrophic effects. A thorough examination with CT or MRI may aid in the early identification of the condition, which may need surgical intervention. Banu et al.[25] reported that 102 out of 258 patients (39.5%) developed pneumocephalus. However, their study included several skull base tumors and approaches, and in most instances, pneumocephalus was very small and clinically not significant. In our study, pneumocephalus developed in 2 out of 55 patients (3.6%); one of them was non-functioning adenoma, and the other was prolactinoma. The first had small pneumocephalus, which responded to conservative treatment, while the other required a burr hole. The estimated incidence of symptomatic pneumocephalus in literature is 0.2–2.5%.[21,22,26]

Diabetes insipidus (DI) after ETPS can increase morbidity and prolong hospital stays.[27] DI is the result of a lack of antidiuretic hormone (ADH). Most reported cases of postoperative DI are transient, manifesting within 24–48 hours of surgery and resolving within 3–5 days postoperatively. In the current study, 29 patients (52.7%) experienced DI; temporary 26 (89.7%), and permanent three (10.3%), which was more significant than the one published in the Mamelak study[28] with a 16–34% range and lower than the incidence reported by Qari et al.,[29] in which 13 out of 24 (54.2%) patients had DI, five (38.8%) were transient, and eight (61.2%) were permanent.

Two patients in our series experienced severe postoperative nasal bleeding. In one of them, epistaxis happened on the 8th postoperative day and was controlled by nasal packing. The other one showed severe epistaxis one week after surgery which recurred despite good packing. We performed endoscopic clipping of the sphenopalatine artery, and the patient was discharged without a nasal pack. Injury to the carotid artery causes severe intraoperative bleeding, which may be fatal if not treated promptly. Fortunately, this complication didn't occur in our series.

Adrenal insufficiency is a known complication of ETPS, with an incidence ranging between 2 and 52%.[30] The different definitions between authors explain this wide range. Predictors include tumor size, preoperative T4, IGF-1, FSH, LH, and urinary-free cortisol source. In our study, the incidence of adrenal insufficiency is 3.6% and is related to larger tumor size (OR 1.07, 95% CI 1.01–1.13). Both required corticosteroid therapy for more than 6 months. No association was found with gender, age, tumor type, prolactin, TSH, testosterone, and cortisol.

The olfactory region is an irregular area, about 2 cm^2 of the posterosuperior portion of the nasal vault. ETPS results in decreased olfaction with or without harvesting HBF due to mucosal sacrifice and scarring.[31] However, the use of HBF for reconstruction can worsen olfactory loss. Several modifications have been suggested to the original HBF to decrease or prevent olfactory loss. Tam and Kim reported a reduction in olfactory scores on leaving just 1 cm superiorly from the olfactory cleft. Due to the limitation of the covid pandemic and the inability to use proper smell tests, we assessed olfaction on a simple analog scale. We considered olfactory loss as permanent if it persisted for more than 6 months. The olfactory changes occur in 28 (50.9%) of the patients; 39.3% of them have transient anosmia, 10.7% permanent anosmia, 42.9% transient hyposmia, and 7.1% permanent hyposmia. Our results are comparable to Tam et al., who found permanent olfactory loss after endoscopic pituitary surgery at 9.11%, and it increased to 19.63% if HBF is used.[32]

Conclusion

Endoscopic transsphenoidal pituitary surgery is a safe approach to pituitary adenomas, avoiding external scars with minimal postoperative morbidity.

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