

Endoscopic Skull Base Surgery in Assiut University, Single Center Early Experience

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Abstract

Background: Endoscopic transnasal skull base surgery had started long time ago in different centers around the world for excision of skull base lesions with good results and more cost effectiveness. The aim of this study is to discuss our early results in endoscopic skull base surgery and the development of the learning curve. **Patients and Methods:** We analyzed our experience regarding 25 patients presented to us in Neurosurgery Department, Assiut University Hospital, Assiut University, Assiut, Egypt in a period of 3 years (2015, 2016, 2017) and operated by endoscopic transnasal approach. All patients signed an informed consent. **Results:** With the highest percentage was pituitary adenoma 56%, pituitary apoplexy 12%, craniopharyngioma 12%, CSF rhinorrhea 12%, Planum sphenoidal meningioma 4% and suprasellar granuloma 4%. 88% of patients were operated without complications, 8% mortality rate postoperative, 12% complication rate and 76% complete improvement postoperative. **Conclusion:** Endoscopic skull base surgery is a safe approach to the skull base that needs a good experience, practice and good anatomical knowledge. Teamwork between a Neurosurgeon and ENT surgeon is a must for patient safety.

Keywords

Endoscopic Transnasal Surgery, Skull Base Surgery, Pituitary Adenoma, Craniopharyngioma

1. Introduction

The idea of reaching the skull base lesions endoscopically through the nasal rout has been started long time ago since the early start to find the ideal approach for pituitary surgery. Sir Victor Horsley, at the end of 19th century, pioneered approaches to the sella by transcranial and transfacial routs. Hermann Schloffer,

reported the first successful pituitary tumor excision through transsphenoidal approach in 1907. Starting from 1910, Harvey Cushing treated 231 pituitary tumor patients via sublabial incision and submucosal dissection of the nasal septum to reach the sella through the sphenoid sinus [1] [2] [3].

Jules Hardy reintroduce the transsphenoidal pituitary surgery in 1965 by introduction of the binocular microscope to perform the procedure [1] [4].

Guiot was the first neurosurgeon who used the endoscope to inspect the seller cavity after microscopic transsphenoidal surgery in 1960 followed by Michael Apuzzo in 1977 who started to use the endoscope to assist the microscope during the transsphenoidal surgery [1] [5].

In 1996, co-operation between neurosurgeon Hae-Dong Jho and otolaryngologist Ricardo Carrau at the University of Pittsburgh, made them start to perform a fully endoscopic skull base procedures with a strictly endonasal approach [1] [6].

Juo and Carrau reported and discussed their approach in a series of 50 patients at the Sixth European Workshop on Pituitary Adenomas (Berlin, July, 1996) [1] [7].

Since that time Jho-carrau endoscopic endonasal skull base approach was adopted and pioneered by multiple centers worldwide.

Endoscopic use in the endonasal skull base approach allowed more clear, superior panoramic view than microscope with the possibility of exploration of angles and deep structures that was very difficult to be seen by microscope. The new technique results in overall decrease in complication rate, improved tumor excision, better preserved nasal airway functions, better patient compliance and shorter hospital stay [1] [3] [7].

In Assiut University Hospital, we started our team work with Otolaryngology department since 2015 and did our first purely endoscopic transsphenoidal approach at the same year. We started with pituitary adenoma cases and after some time of gaining experience we started to do more difficult cases with more complicated pathology like meningiomas and craniopharyngiomas.

In this article, we reviewed our results in three years and discuss the achievement and progress in our learning curve.

2. Patients and Methods

This is retrospective descriptive study to review the results of 25 patients who presented with skull base lesions that can be approached endoscopically through a transnasal approach.

All cases presented to us at Neurosurgery department, Assiut University, Assiut, Egypt during a period of time of 3 years (January 2015 to December 2017).

Patients were carefully selected in a base of lesion accessibility transnasally and acceptance of the patients on the approach.

Our plane is to study the following variables:

- Demographic data.

- Rates of different pathologies presented to us.
- Presenting symptoms and signs.
- Rate of hormonal abnormalities in our study.
- Approaches used by our team.
- Extent of resection of excisable lesions.
- Outcome and improvement rate.
- Complications rate.
- Mortality rate.
- Recurrence rate during the follow up period.
- The development of our learning curve.

All patients were informed about the approach, technique, possible complications, postoperative course and the alternative treatment possibilities, and they signed an informed consent with previously mentioned information.

We used the following storz endoscopic equipment's:

- Hopkins[®] straight forward telescope 0° and 30°.
- Image 1 S camera head with 3 chip full HD view.
- Cold light fountain xenon nova[®] 175 light source.
- Karl Storz clearvision[®] II system for irrigation and intraoperative rinsing of the telescope lens.

2.1. Inclusion Criteria

All cases presented with seller-supra-seller lesions or any skull base pathology that need surgical intervention and can be operated through trans nasal endoscopic approach.

2.2. Exclusion Criteria

- Lesions that appear to have para-seller extension.
- Lesions that appear to be invasive in nature.
- Inclusion of one or more of neurovascular structures within the lesion.
- Patients refuse the approach.

2.3. Preoperative Investigations

All patients diagnosed with a skull base lesions prepared with a preoperative investigation: Detailed history, general and neurological examination, ophthalmological examination (fundus, visual field and visual acuity) by ophthalmologist, nasal examination by otolaryngologist, complete hormonal profile, CAT scan of the head and paranasal sinuses and MRI of the head.

2.4. Operative Approach

After general anesthesia, patient positioned in supine position with head centered and slightly elevated 20°, slightly tilted to the right and placed over a horseshoe headrest. Antibiotic and dexamethasone are given to the patient intravenous. Cottonoids soaked with epinephrine 1:100,000 inserted into both

nostrils to vasoconstrict the nasal mucosa. Otolaryngologist and neurosurgeon stand on either side of the patient. Endoscope entered into the nostril, explore the nasal anatomy and advanced to the choana, retraction of the middle and superior turbinate's laterally, identification of the sphenoid ostium approximately 1.5 cm above the choana, opening the ostium with mushroom punch and Kerrison rongeur, resection of the posterior septal mucosa and resection of the posterior part of the nasal septum. The same previous steps done for the other nostril to work through both nostrils. Entering the sphenoid sinus and explore the carotid prominences, seller floor and the optic prominences, opening the seller floor with osteotome or high-speed drill, opening the dura in cruciate fashion, tumor removal either en-bloc removal or by use of ring curettes, hemostasis of the cavity by gel foam. In case of CSF leak we place fat into the pituitary cavity. In cases with sphenoidal tumors we extend the bone removal into the planum sphenoidal and in closure we do a gasket seal repair with naso-septal flap coverage. In gasket seal repair we insert fat followed by fascia Lata over the dural defect, insertion of a piece of bone from the nasal septum then nasoseptal flap and finally fibrin glue. We insert a small piece of teflon at each nostril and remove after 24 to 48 hours.

In cases of CSF rhinorrhea according to the site and the size of the defect, we mainly repair it with gel foam, fat, fibrin glue and vascularized nasal septal flap.

2.5. Follow Up

The mean follow up period was one year \pm 6 months. An immediate follow up CAT scan is always done within the first 48 hours after surgery and a follow up MRI after 6 months. Follow up hormonal profile after 24 hours and after one month. Follow up urine output in the first 5 days after surgery.

2.6. Statistical Analysis

Data was collected in Excel sheet (Microsoft office 2016) then analysis was done. The results were expressed in terms of percentage.

2.7. Ethical Considerations

The study was conducted after getting ethical clearance and the permission from Assiut University teaching hospital administration. Thorough explanation of the purpose of the study and how data will be treated with respect and confidentiality was provided to the participants. All patients and their first-degree relatives informed about their condition, the disease, about the risks of surgery and anesthesia and also informed about the other surgical treatment options. All patients signed an informed consent.

3. Results

25 patients underwent operations through endoscopic transnasal approach for different varieties of skull base lesions. Mean age was 39.36 ± 12.24 (15.0 - 61.0), 13

males and 12 females with a percentage 52% and 48% respectively.

The most common pathology was pituitary adenoma (56%) and pituitary apoplexy (12%) representing total (68%) as a pituitary related pathology. 3 patients with craniopharyngioma (12%). 3 patients with CSF rhinorrhea representing (12%), one case of planum sphenoidal meningioma and one case of suprasellar granuloma. All cases are diagnosed preoperatively by MRI of the brain, intra-operative gross pathology and postoperative histopathological examination (**Table 1**).

3.1. Symptoms and Signs

Headache was the most common symptom (20 patients—80%), Visual deterioration was the second most common symptom (16 patients—64%). 3 patients presented with CSF Rhinorrhea (12%) (one postoperative and 2 spontaneous), galactorrhea-amenorrhea in 4 patients (16%), acromegaly in 2 patients (8%), Cushing in one patient (4%).

3.2. Preoperative Hormonal Profile

7 patients had disturbed hormonal profile preoperative, one patient with increased ACTH, 4 patients with increased prolactin and 2 patients with increased growth hormone.

Approaches used in our series were as following.

The most majority of the used approaches were the trans-sphenoidal transsellar approach which used in 17 patients (68%) all were pituitary adenoma cases.

Endoscopic transsphenoidal trans-planum approach used in 5 cases (20%) 3 cases of craniopharyngioma, one case of planum sphenoidal meningioma and one case of suprasellar granuloma (**Table 2**).

In 3 cases of CSF rhinorrhea we made the skull base repair according to the

Table 1. Types of lesions by histopathological examination and gross appearance.

Diagnosis	No. (n = 25)	%
Pituitary adenoma	14	56.0
Craniopharyngioma	3	12.0
Pituitary apoplexy	3	12.0
Planum sphenoidal meningioma	1	4.0
CSF rhinorrhea	3	12.0
Suprasellar granuloma	1	4.0

Table 2. Approaches used in our study.

Procedure	No. (n = 25)	%
Endoscopic trans-sphenoidal, trans-planum excision	5	20.0
Endoscopic trans-sphenoidal, transsellar excision	17	68.0
Endoscopic trans-nasal repair	3	12.0

site of the skull base defect.

3.3. Extent of Resection

The total number of patients with a pathology needed to be excised was 22 patients. Gross total resection (GTR) was achieved for 16 cases (72.7%), near total resection (NTR) was achieved in 2 patients (9%) and partial resection (PR) was done for 4 patients (18.2%).

3.4. Hospital Stay

The mean hospital stay in our series was 5.32 days postoperative ranging from 3 to 10 days.

The outcomes in our series were as following.

There were no complications in 22 cases either intraoperative or postoperative. One case of planum sphenoidale meningioma complicated with postoperative CSF rhinorrhea. One case of recurrent pituitary adenoma complicated with postoperative interventricular hemorrhage and subarachnoid hemorrhage and one case of craniopharyngioma complicated with postoperative diabetes insipidus and hypothalamic dysfunction.

Improvement happened postoperative for 19 patients (76%), 4 patient's operation ended up with partial excision (3 patients of pituitary adenoma and one planum sphenoidal meningioma).

We have 2 patients died postoperative in our series (8%) one the recurrent pituitary adenoma from interventricular hemorrhage and the other with craniopharyngioma from hypothalamic failure.

We have only one case of recurrent pituitary adenoma 2 years after the first operation during the study which needed reoperation (**Table 3**).

Table 3. The main outcome, complications rate, improvement rate, recurrence rate, and mortality rate in the study.

	No. (n = 25)	%
Complications:		
No complication	22	88.0
CSF rhinorrhea	1	4.0
SAH, IVH	1	4.0
diabetes insipidus, hypothalamic dysfunction	1	4.0
Recurrence:		
Yes	1	4.0
No	24	96.0
Result:		
Improved	19	76.0
Died	2	8.0
Partial excision	4	16.0

4. Discussion

Ancient Egyptians were the leaders and pioneers in medicine and surgery. They did brain surgeries for some intracranial diseases as founded in Egyptian papyrus writings from 17th century BC which is believed to be written by Imhotep. Ancient Egyptians were the first mankind to reach the brain through the nose and skull base. They used this approach to do excerebration (evacuation of the brain) during the process of mummification [8].

In recent history, the trans-sphenoidal approach was reintroduced as a safe, minimally invasive approach to reach the pituitary gland and skull base pathologies to decrease the complications and cost of cranial surgeries [1] [3].

Improved endoscopic equipment's and quality of optics, camera and screens, and the co-operation with Ear, Nose and throat (ENT) surgeons in 1990s led to development of pure endoscopic endonasal technique to reach skull base pathologies [1] [3].

Trans-nasal skull base surgery started in Assiut University since 1990's. 2 teams started it, each team consists of a Neurosurgeon and ENT consultants.

Both teams were approaching the sella with microscopic sublabial approach and submucosal trans-septal approach.

Pure endoscopic transnasal approach has been started in 2015 with old endoscopic equipments. We started our work with pituitary adenoma cases only as we considered it the easiest pathology to reach within the skull base with the least complications. At that time, we don't want to go further into more complicated pathology till we are familiar with the endoscopic skull base anatomy, familiar with the bi-nostril four-hand technique and experienced enough in dealing with intraoperative and postoperative complications.

In middle of 2015 we upgraded our endoscopic system with a storz[®] HD camera and monitor, also all the surgical instruments were upgraded.

As a benefit from using that advanced equipment's and gaining more experience in the approach we started to do the pituitary adenoma cases more efficiently and in much shorter intraoperative time, also we started to approach into more difficult pathologies like planum sphenoidal meningioma, craniopharyngioma, suprasellar granuloma and CSF leak repair for the skull base.

In this study we reviewed our results in 25 patients who presented to us in Neurosurgery department, Assiut university hospital, Egypt, between January 2015 and December 2017, with skull base lesions.

All patients operated by a pure endoscopic endonasal approach, bi nostril four-hand technique by Neurosurgeon and ENT surgeon.

The mean age in our study was 39.36 ± 12.24 years old.

The most common presentations in our study were headache in 80%, visual deterioration 64%, CSF rhinorrhea 12%, amenorrhea-galactorrhea syndrome 16%, acromegaly 8% and Cushing syndrome 4% (total endocrinopathy 28%). Mascarenhas *et al.* reported the most common complications in their study, visual deterioration was the most common symptom (73.81%), followed by head-

ache (28.56%), and endocrinopathy (16.6%) [9].

The most common pathology was pituitary adenoma and apoplexy (68%), craniopharyngioma 12%, CSF rhinorrhea 12%, planum sphenoidal meningioma and suprasellar granuloma 8%. In Kutlay *et al.* study they reported that pituitary adenoma was the most common pathology 25.4%, followed by sinonasal malignancy 16.9%, CSF leak 15%, meningioma 11.3%, craniopharyngioma 7.5% [10].

Pituitary adenoma was also the most common pathology in Mascarenhas *et al.* study 51.6% followed by craniopharyngioma 20.6% [9].

Regarding the extent of resection, the rate of GTR in our series was 72.7%, NTR was 9% and PR was 18.2%. GTR achieved by complete excision of the lesion with clear intraoperative surrounding boundaries and confirmed by postoperative imaging. NTR achieved when the remaining part of the lesion is less than 20%. PR achieved when only 50% or less of the lesion has been excised. In Kutlay *et al.* series they achieved GTR in 75% and NTR and PR in 25%, which are close to our results. Also the same in Mascarenhas *et al.* study as they achieved GTR in 77.5% and NTR in 12.5% [9] [10].

The complication rate in our series was 12%. Postoperative complications were CSF leak in a partially excised planum sphenoidal meningioma patient which improved spontaneously with medical treatment and lumbar drain within 5 days postoperative, massive subarachnoid hemorrhage and interventricular hemorrhage in a patient with recurrent pituitary adenoma, there was no obvious bleeding intraoperative but we found that patient has a disturbed conscious level postoperative, urgent CAT scan for brain was done and we inserted a ventricular drain for drainage and ICP (intra cerebral pressure) monitoring in ICU, but unfortunately patient died in the second postoperative day.

The third patient complicated postoperative after excision of craniopharyngioma. Intraoperative course was classic and the cyst was within the sellar and suprasellar compartments. Post-operative patient has a disturbed conscious level and severe diabetes insipidus with electrolyte disturbance, patient diagnosed as a hypothalamic dysfunction. Intensive management was done for the patient in ICU. Patient died in the 5th day postoperative.

Death rate in our series was 8%, as previously mentioned.

We have only one case with recurrent pituitary adenoma (4%) 2 years after the first surgery which needed a reoperation via the same approach.

Kutlay *et al.* have a complication rate 8.5% in their series mainly in the form of CSF leaks postoperative, cranial nerve deficits and panhypopituitarism. Mascarenhas *et al.* have also a complication rate 12.58%. Both are close to our series results with consideration of the larger number of patients in both series as in Kutlay *et al.* study included 106 patients and in Mascarenhas *et al.* study 122 patients underwent 126 surgeries [9] [10].

The mean hospital stay in our series was 5.32 days postoperative ranging from 3 to 10 days.

Decrease the Hospital stay and lowering complication rate are the main rea-

sons the make endoscopic skull base surgery has a more cost effectiveness than microscopic and cranial approaches for management of the same skull base lesions [11].

Recent studies also defined the endoscopic endonasal skull base approaches as a safe and effective alternative surgical approach for managing skull base lesions in pediatrics and elderly patients above 70 years old [12] [13].

Regarding the learning curve development, we believe that every neurosurgeon and ENT surgeon must start their endoscopic skull base surgery development with 3 very important steps, first careful anatomical study of the endoscopic skull base anatomy, second careful observation of endoscopic skull base surgeries with one of the professional endoscopic skull base teams, and third to do a lot of cadaveric dissection and hands on anatomical study with the endoscope.

Starting to operate after completing the first steps in learning curve is actually a start of the real learning curve as patient is the best teacher.

One way to assess the learning curve development is to evaluate the results and complications rate across time. Smith *et al.* estimated the number of cases needed to advance beyond the learning curve and reach the plateau in outcomes is to be between 18 and 34 patients [14].

Kshetry *et al.* divided his series into early cohort (20 patients) and late cohort (23 patients), they noticed that the extent of resection was significantly different between both groups, as the GTR was achieved in 65% of cases in the late cohort compared to 20% in the early cohort. Also, the same was for complication rate as they found that it was 14% in the early cohort and only 4% in the late cohort [15].

They concluded that there is significant improvement in the results and decrease in complications after operating 20 cases.

In this study there were 3 complicated cases and 2 of them ended by death. CSF rhinorrhea in one case after partial excision of a planum sphenoidal meningioma, this case was in the first year of the study (2015) and due to lack of enough experience, it was very difficult to dissect the tumor from the optic nerves and we preferred to stop to preserve the remaining vision, also during the repair we only inserted fat followed by a layer of fascia lata which resulted in postoperative CSF leak. After this case we started to do gasket seal repair and cover it by a naso-septal flap in all our cases with high flow leak intraoperative.

The 2 other complicated cases were also in the first year and early second year of this study which also was our early experience, both cases died postoperative. One craniopharyngioma complicated with hypothalamic dysfunction and severe diabetes insipidus after GTR. The other case was a recurrent pituitary adenoma and complicated postoperative by massive subarachnoid hemorrhage and intraventricular hemorrhage.

We had neither morbidity nor mortality in the rest of this study (2016 and 2017). The improvement of the results may explain by improvement in the experience of the operating team, better understanding of the anatomy, improved

skills of dissection and repair.

5. Conclusion

Endoscopic skull base surgery is a safe approach for management of selected skull base lesions with a low complication, mortality rate and postoperative hospital stay which make this approach more cost effective. Learning curve needs at least one year of practice to reach its plateau. Certain time must be spent in studying the endoscopic skull base anatomy, cadaveric dissection and observation of a professional skull base team.

Limitations of the Study

- Early experience.
- Relatively small number of patients especially in craniopharyngioma and meningioma patients.
- Equipment's limitations.

Recommendations

A further study is needed with more patients and specifies the teamwork experience in each lesion separately.

Conflicts of Interest

The authors declare that they have no competing interest.

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