

ENDOSCOPIC ENDONASAL TRANSSPHENOIDAL APPROACH FOR REMOVAL OF SELLAR AND PARASELLAR BRAIN LESIONS – ADVANTAGES AND LIMITATIONS

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Abstract

The endoscopic endonasal transsphenoidal surgical approach is a minimally invasive neurosurgical procedure in the treatment of sellar and parasellar brain lesions. According to the literature reports, the results are comparable or even better with respect to surgical radicality. This approach is associated with reduced morbidity, faster recovery times, and superior visualization of the surgical field, making it an increasingly preferred option in neurosurgery.

The aim of this study is to update the knowledge and the information of the transnasal transphenoidal surgical approach and treatment of brain lesions, its application and outcomes, advantages and disadvantages of this technique.

Increasing experience with this technique can decrease rates of complications. A trend towards a lower total complication rate with increasing study size was observed.

The review of complications of transsphenoidal surgery showed that transsphenoidal surgery seems to be a reasonably safe procedure, with a mortality rate of less than 1%, with a significant number of complications which were more frequent in less experienced surgeons. Many researches showed similar results when analyse the complications after endonasal endoscopic surgery.

Compared to more traditional surgical techniques, endonasal transphenoidal endoscopy showed lower rate of neurological complications, greater improved in visibility, moderate rate of endocrinological disturbance and higher rate of cerebrospinal leakage.

Main advantages of the endonasal approach are the direct access to the sellar region without brain retraction and a straight forward procedure. Major drawbacks are the increased risks for postoperative CSF fistulas, sinonasal complications and the limited access to lateral structures.

Modern technical innovations in endoscopic endonasal skull base surgery like enhance the safety, efficacy, and overall success of the endoscopic transnasal approach to sellar, suprasellar and other skull base brain lesions.

Keywords: Endoscopic, endonasal, transsphenoidal, brain lesions, neurosurgical

Introduction

Fast development and progress of endoscopic technology in general enable the endoscopic endonasal transsphenoidal approach to become one of the best surgical methods for resection of sellar and suprasellar tumors [1].

The endoscopic endonasal transsphenoidal surgical approach is a minimally invasive neurosurgical procedure in the treatment of brain lesions and other pathologies at the skull base. Using this method, as opposed to the traditional surgical approach, has been shown to have numerous advantages [2, 3].

The most significant benefit is the visualization of the operative field through the possibility of a larger field of view. The surrounding tissue, when using the endoscopic endonasal transsphenoidal approach, has a significantly lower degree of surgical trauma [4]. Postoperative and operative complications

are reduced considerably. Hospital days when performing this type of procedure are also reduced. Patients who have undergone this type of procedure in the treatment of a lesion in the sellar or parasellar region of the brain experience less discomfort [5].

The transsphenoidal neurosurgical approach was established almost one hundred years ago for surgical treatment of the tumours contained within the sella or suprasellar cistern. Several transsphenoidal approaches were design to achieve complete removal of the tumors and avoid possible complication [6].

Over the last century, the transsphenoidal approach has evolved into the first-line method of treatment for sellar as well as select groups of parasellar and suprasellar lesions, and during this period its popularity dynamically changed from very popular to almost abandoned [7, 8]. Endoscopic neurosurgery is modern surgical technique introduced as optimal option for treatment of various neurological (neurosurgical) pathology such as treatment of obstructive hydrocephalus, other obstruction of cerebrospinal fluid pathways, ventriculostomy, pituitary tumors etc [9, 10].

Specific type of endoscopic neurosurgery is endoscopic endonasal transsphenoidal technique [EETST] which was initially reserved only for sellar lesions trough sphenoid sinus cavity. This technique enables approach to midline skull base which traditionally was approached transcranially [11].

Cappabianca and colleagues used EETST to access some different compartments also called “dangerouse landmarks”. They performed 33 extended endonasal approaches, and reported complete removal of the lesion in 2/6 pituitary adenomas, 7/10 craniopharyngiomas, 4/5 meningiomas, 3/3 Rathke's cleft cyst, 3/3 meningo-encephalocele.

The widespread use of the endoscope in transsphenoidal pituitary surgery has recently contributed to the extension of the approach beyond the tuberculum sellae and planum sphenoidale for the management of lesions located in the suprasellar area, either with an endoscope-assisted or purely endoscopic technique [12].

A purely endoscopic endonasal approach to suprasellar supradiaphragmatic lesions is a feasible minimally invasive alternative to craniotomy and with a multilayer closure, the risk of CSF leakage is low and lumbar drainage can be avoided [13].

The advantages of endoscopic endonasal transsphenoidal surgery (EETSS)

The increasing cumulative experience with the endoscopic endonasal transsphenoidal technique for pituitary surgery, the improved visualization and less steep learning curve will facilitate more widespread acceptance of endoscopic pituitary surgery as a valid alternative to the trans-septal trans-sphenoidal microscopic approach to pituitary tumors [14].

The endoscopic endonasal transsphenoidal approach is one of the preferred surgical methods for treatment of sellar or suprasellar tumor. Liu end colleagues reported that there was no recurrence in all patients [21] during the follow-up period [up to 52 months] [1].

The extended transsphenoidal approach is a less invasive method for removing purely suprasellar lesions compared with traditional transcranial approaches. Most supporters have used a sublabial incision and a microscope and have reported a significant risk of cerebrospinal fluid [CSF] leakage [13].

The endoscopic extended transsphenoidal approach for suprasellar craniopharyngiomas may be a really alternative to the transcranial approach in many cases. The long follow –up period, mean 42 months. maximum 120 month after surgery, showed that resection of suprasellar craniopharyngiomas using the extended endoscopic approach was a more effective and less traumatic technology, able to provide resection of the tumor along with high quality of life after surgery, and relatively rare postoperative complications and mortality [15].

The expanded endonasal endoscopic transsphenoidal approach has become increasingly used for craniopharyngioma surgery in the pediatric population. The endoscopic transsphenoidal approach affords the ability to directly inspect the hypothalamus to determine invasion, which may help spare the patient from hypothalamic injury [16].

Most of the advantages of the endoscopic endonasal technique were noted during tumor dissection from the inferior aspect of the chiasm, the infundibulum, the third ventricle, and/or the retro- and parasellar

areas. These benefits were best appreciated in patients who had originally undergone transcranial surgery, since in such cases the authors' endoscopic endonasal approach was a virgin route. However, the extended endoscopic endonasal technique can also be safely used in patients who originally underwent transsphenoidal surgery. The endoscopic endonasal technique should be considered as a therapeutic option in selected cases of recurrent or symptomatic residual craniopharyngiomas [17].

Removal of recurrent or residual symptomatic craniopharyngiomas is more challenging than the primary surgery. The pure extended endoscopic endonasal [EEE] approach is a safe, effective alternative for treatment of recurrent or residual symptomatic craniopharyngiomas owing to its advantages including wide-angle view, close observation and elimination of brain retraction [18].

The multidisciplinary EEEA [extended endoscopic endonasal approach] to craniopharyngioma resection represents a safe and compelling alternative to TCM [transcranial microsurgery]. The authors' data demonstrate that postoperative visual improvement is statistically more likely in the EEE approach despite the increased risk of CSF leakage. These results add to the growing evidence that the EEEA may be considered the approach of choice for resection of select confined primary craniopharyngiomas without significant lateral extension in centers with experienced surgeons [19].

Craniopharyngiomas have traditionally represented a challenge for open transcranial or transsphenoidal microscopic neurosurgery because of their anatomical location and proximity to vital neurovascular structures. The results of an older but very extended study which analyse eight studies with 3470 patients involved, claimed that the endoscopic endonasal approach is a safe and effective alternative for the treatment of certain craniopharyngiomas [20]. Larger lesions with more lateral extension may be more suitable for an open approach, and further follow-up is needed to assess the long-term efficacy of this minimal access approach.

High rates of near or total resection and visual improvement can be achieved using an endoscopic endonasal approach for craniopharyngiomas. Also the authors found evidence for a learning curve. After 20 cases, they found a significant decrease in major neurological complications and significant increases in the rates of GTR rate and discharge to home.

Although there was a large decrease in the rate of postoperative CSF leak over time, this was largely attributable to the inclusion of very early cases prior to the routine use of vascularized nasoseptal flaps. There was a significant increase in new panhypopituitarism and diabetes insipidus, which is attributable to increase rates of intentional stalk sacrifice [21].

The endoscopic approach is an increasingly accepted technique for anterior skull base tumor surgery and is associated with acceptable complication rates. Increasing experience with this technique can decrease rates of complications. A trend towards a lower total complication rate with increasing study size was observed [22].

Incidence of the complications after endoscopic endonasal transsphenoidal surgery

The review of complications of transsphenoidal surgery which took in considerations analysis of literature, national survey and personal experience included almost one thousand surgeons which were performed this kind of surgery.

The data from questionnaire showed that mean mortality rate was 0.9%, anterior pituitary insufficiency has incidence of 19.4% and diabetes insipidus 17.8%. According this paper transsphenoidal surgery seems to be a reasonably safe procedure, with a mortality rate of less than 1%, with a significant number of complications which were more frequent in less experienced surgeons. [23]. Surgical complications have been observed in 3/33 patients [10%], who developed a CSF leak and a second operation was necessary in order to review the cranial base reconstruction and seal the leak and one of them ending with surgical mortality [11].

The analysis of 105 surgical cases of patients expose to standard and extended transphenoidal approaches, during the period of 20 years [1982-2003], showed no mortality, 1 case of monocular blindness, 1 case of diabetes insipidus, 2 case of permanent cavernous cranial neuropathy [24] .

Evaluation of the effectiveness of the extended EETS approach in the management of lesions mainly located in the suprasellar area revealed that the improvements in closure techniques and the use of new materials and surgical glues seem to significantly reduce the postoperative cerebrospinal fluid leak rate and meningitis [12].

In the study with small number [10] patients endoscopic endonasal approach was used to remove suprasellar lesions, the pituitary stalk was preserved in all but one patient, and 6 patients had temporary diabetes insipidus and four patients required hormone replacement. With a multilayer closure, the risk of CSF leakage is low and lumbar drainage can be avoided. [13].

In investigation of 204 patients with supradiaphragmatic tumors which underwent removal with EETSS there was improvement or absence of visual deterioration in 89% and worsening of vision in 11% of patients. Regarding hypothalamus-pituitary function worsening was observed in 42.6%, bacterial meningitis in 16%, CSF leaks in 8.8% and the lethality was 5.8% [16]. Total and subtotal removal of residual craniopharyngiomas [22 patients] via the extended endoscopic transsphenoidal approach, there were no deaths or major complication, postoperative CSF leaks developed in 3 patients [13.6%] [8].

Similar retrospective study in residual symptomatic craniopharyngiomas showed that visual acuity was improved in 10 out of 15 cases, only one patient suffered postoperative endocrine dysfunction, no CSF leaks were identified [18]. The study which compares endoscopic endonasal with microscopic transsphenoidal and open transcranial resection of craniopharyngeomas, endoscopic cohort had significantly greater rate of gross total resection and improved visual function. While transcranial group showed greater rate of seizures [which did not occur in the endonasal or transsphenoidal groups], CSF leakage was greater in endoscopic and transsphenoidal groups [18.45 vs 9%] [20].

Eleven pediatric patients [mean age = 7.9 years] with different kind of craniopharyngeomas underwent surgery via an endoscopic transsphenoidal approach. Anterior pituitary dysfunction occurred in 81.8% of the patients, and 63.3% developed diabetes insipidus. Visual function was stable or improved in 73%. All children returned to an academic environment, with 10 of them in the grade appropriate for their age. There was a single case of each of the following: CSF leak, loss of vision unilaterally, and abscess [16]. The assessment of the outcome of endoscopic endonasal surgery in a consecutive series of craniopharyngiomas with special attention to extent of resection with mean follow up of 35 months noticed improved vision in 77%.

Diabetes insipidus and panhypopituitarism developed in 42% and 38%, respectively. A more than 9% increase in BMI occurred in 39%; 69% returned to their preoperative profession/schooling. The postoperative CSF leak rate was 3.8% [25].

In the single center cohort study on 79 patients during 4 years period of time, after mononostril endoscopic procedures two patients had persisting CSF fistula and one of them meningitis. There was a significant decrease of nasal complaints during follow up after 2 years [$p < 0.001$]. Further surgical treatment by ENT physician was necessary in 11.4% [26].

A huge systematic review of complications after endoscopic endonasal anterior skull base surgery include 82 relevant studies [during the past 65 years, before 2016] with participation of almost eight thousand patients an average overall complication rate of 17.1% [range 0%-68.0%] and a mortality rate of 0.4% [0%-10.0%].

The average CSF leak rate for all studies was 8.9% [0%-40.0%] with meningiomas and clival lesions having the greatest CSF leak rates. A trend towards a lower total complication rate with increasing study size was observed [22].

The outcomes of extended endoscopic transnasal skull base surgery was analysed in 45 cases, and postoperative cerebrospinal fluid leak was the most common complication observed in 9 patients [20%], major vascular complications occurred in 2 patients [4.4%] and no mortality was observed [3].

The indications for EETSS

The choice of the approach, between endonasal endoscopic approach as alternative option to the transcranial microsurgical approach, depends on tumor size and location, involvement of important

neurovascular structures, and, most importantly, the surgeon's preference and experience. Based on a high level of experience and low complication rates, the endonasal technique is the first choice in most neurosurgical centres for treatment of pathologies in the sellar region [26].

Object in the last decade the indications for the endoscopic endonasal approach have been progressively expanded to include lesions that have not been traditionally considered amenable to resection through the transsphenoidal route [27].

We will numerate the most frequently brain lesions which could be treated with endonasal endoscopic surgery.

- Pituitary tumors [adenomas and carcinomas]: The majority of pituitary tumors are benign adenomas. Tumors can be hormonally active and begin to manifest as clinically identifiable syndromes that are associated with excessive hormone production. Inactive small adenomas usually cause no symptoms and are often an incidental finding. [XX] In a retrospective analysis of endoscopic pituitary surgery in 150 patients treated with EETSS authors observed a decreased incidence of complications with respect to the surgical trauma, the functionality of the pituitary gland and post-operative patient comfort [28]. Telementoring for the endoscopic endonasal approach to pituitary neoplasms enables low-volume centres to achieve efficiency, decreasing rates of postoperative complications and increasing the extent of tumour resection. The proportion of complication-free patients significantly increased over the observed period [60% vs. 79%] [29]. The endoscopic transsphenoidal surgery for functioning pituitary adenomas leads to a better endocrinologic outcome for noninvasive macroadenomas compared to the traditional microsurgical technique. The morbidity with the endoscopic technique was higher in terms of the rate of postoperative CSF leaks [30]
- Craniopharyngiomas - are rare brain tumors that originate from embryonic tissue of the pituitary gland, most often in children, but also occur in the adult population. The highest incidence in children is between 5-14 years of age, and in the adult population, it is between 50-74 years of age. [15-18]
- Rathke's cysts are benign growths of the pituitary gland, filled with a mucinous substance, which are located in the posterior portion of the anterior part of the pituitary gland. It is often difficult to distinguish RCCs from other neoplastic lesions during diagnostic investigation because of a wide variability of appearance in radiological imaging [31].
- Sinonasal malignancies represent a rare subset of tumors with a wide variety of histopathologic diagnoses and overall poor prognosis. For selected cases, endonasal endoscopic techniques can be performed with curative intent and reduced surgical morbidity and mortality [32]. In the late 1990s and early 2000s, endoscopic approaches were applied to resection of sinonasal malignancies [33].
- Hypothalamic gliomas - Early experience with the endoscopic endonasal approach has revealed it to be a direct, straightforward, and safe approach to third ventricle astrocytomas. It allowed the authors to perform tumor resection with the same microsurgical technique: dissecting the tumor with 2 hands, performing a central debulking, and controlling the bleeding with bipolar coagulation [27].
- Intraseellar meningiomas or planum sphenoidal meningiomas—Suprasellar meningiomas make a relevant distinction when it comes to sellar/suprasellar masses.
- Cavernous sinus [CS] tumors often are considered inoperable. Endoscopic endonasal surgery provides an easily accessible midline corridor to the CS with equivalent or superior results to transcranial approaches in the management of select tumors. Symptomatology due to CS invasion is more likely to improve in pituitary adenomas and the rate of surgical complications is greater in nonadenomas. Using a team approach, the overall mortality due to vascular injury is low [34].
- Congenital, iatrogenic, or post-traumatic meningoencephaloceles in the sphenoid-ethmoidal region ect.

New indications of endoscopic nasal surgery involving orbital and skull base pathologies are expanding [35].

Studies show a superiority of this technique in many indications including some malignant diseases. These studies however, have to be interpreted cautiously, as their follow-up is limited and their design does not include randomisation [36-38]

Modern technical innovations in endoscopic endonasal skull base surgery like HD-endoscopy or angled optics allow minimal-invasiveness with highly satisfying outcomes and low complication rates as described before [18, 26].

Main advantages of the endonasal approach are the direct access to the sellar region without brain retraction and a straight forward procedure [39]. Major drawbacks are the increased risks for postoperative CSF fistulas, sinonasal complications and the limited access to lateral structures [40].

Endoscopic endonasal procedures to skull base lesions achieve high radicality with low complication rates. However, they induce temporary and permanent nasal complaints and complications. Thereby, resurgeries increase the risk of nasal complaints and the use of nasal tamponades might increase the sinonasal outcome.

Further prospective studies are necessary to objectify the evaluation of postsurgical nasal complications [41].

Conclusion

The efficacy and the minimally invasive nature of the fully transnasal endoscopic procedure in the treatment of pituitary adenomas and other lesions of the sellar area have been widely reported in the literature.

Due to the increasingly refined technology and skill, transnasal endoscopic approaches become a preferable choice for many neurosurgeons.

The endoscopic endonasal transsphenoidal approach has the following advantages over the conventional microsurgical technique:

- allows an excellent view of the operating field;
- less invasive method;
- lower level of complications;
- less postoperative discomfort;
- shorter hospital stays and
- lower treatment costs.

The endoscopic approach is a significant change for neurosurgeons who are experienced with microscopic techniques, with well-documented operational outcomes.

There is a learning curve with this strategy. Successful endoscopic pituitary surgery requires extensive training in the use of an endoscope and careful planning of the surgery.

It is necessary close cooperation between a multidisciplinary team consisting of endocrinologists, neurosurgeons, ear, nose and throat surgeons, radiologists, and radiation oncologists is of utmost importance.

Further prospective, multiinstitutional collaboration is needed to power studies capable of fully evaluating indications and appropriate approaches for endonasal endoscopic transsphenoidal surgery.

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