



A comparison between collaborative and single surgeon approach in endoscopic endonasal surgery to sphenoid sinus

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Abstract

Purpose Endoscopic endonasal transsphenoidal surgery (EETS) requires abundant collaborative work between neurosurgeon and ear, nose, and throat (ENT) surgeon. In low-volume centers, however, the surgery may be carried out completely and solely by a neurosurgeon. The current study evaluates the differences in both technique and complications in the approach to the sphenoid sinus for endoscopic endonasal approach (EEA) performed solely by a single neurosurgeon compared to collaborative effort between neurosurgery and otolaryngology.

Methods The study comprises 50 consecutive patients with intra-sellar pituitary lesions undergoing EETS. Half of the patients were operated completely by single neurosurgeon (group A) and the other half by collaboration between single ENT surgeon, as a primary surgeon during nasal step, and the neurosurgeon (group B). Both groups were assessed intra-operatively as to operative technique, average time of EEA to sphenoid sinus, and presence of endonasal structural difficulties and complications.

Results A significant difference was recorded between both groups regarding average time of EEA to sphenoid sinus ($P < 0.001$) and incidence of intraoperative nasal complications ($P = 0.006$). There was a difference between ENT surgeon and neurosurgeon adopting the same approach to sphenoid sinus. Sphenoid sinus approaches from group B characterized by their short duration (mean 10 vs 22 min) and low incidence of intraoperative endonasal complications (4.8% vs 28%).

Conclusion Study results emphasized the necessity of collaboration between neurosurgeon and ENT surgeon in endoscopic endonasal approaches, to efficiently deal with intraoperative endonasal difficulties and complications which pose difference for both surgeons performing the same surgical procedure.

Keywords Endoscopic surgery · Transsphenoidal approach · Anatomical variants

Introduction

Endoscopic endonasal surgery is a valuable procedure that is used routinely for treatment of chronic sinusitis and for approaching the sella turcica [1]. Otolaryngologists always depend on endoscopic techniques for treatment of sinonasal

inflammatory disorders [2, 3] and also for the extended malignant lesions including cases with isolated sphenoid sinus involvement [4]. Increased visualization and positive results provided by endoscopy for sinonasal surgery encouraged neurosurgeons to apply endoscopic techniques for transsphenoidal approaches to the sellar region [2].

Endoscopic transsphenoidal approaches require collaboration among the surgical team members, particularly the neurosurgeon and the ENT surgeon who are required to understand the nuances of each other's field [5]. Nasal anatomic variations, extensive skull base lesions and also extended EETS necessitate such collaborative work [6].

Since in low-volume centers, the neurosurgeon may carry out the whole procedure including the nasal step of surgery particularly, in the pure intrasellar lesions without suprasellar or parasellar extensions that require extended approaches and imperative collaboration with the ENT

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surgeon. The aim of current study is to evaluate whether the surgical technique specific for each surgeon, endonasal structural variants, and abnormalities make any difference between neurosurgeon and ENT surgeon performing the same endoscopic endonasal approach (EEA) to sphenoid sinus.

Materials and methods

We reviewed the hospital discharge database between 2010 and 2016 for only patients with intrasellar pituitary lesions ($n=84$) that commonly underwent EETS by neurosurgeon alone ($n=58$) or by ENT surgeon and neurosurgeon ($n=26$). Outcome reports for the cases operated by neurosurgeon alone showed several intraoperative and postoperative nasal complications such as bleeding, flail middle turbinate, and septal perforation. Some reports recorded intraoperative calling of ENT surgeon to the operating theater for controlling some endonasal difficulties. With growing experience, supported by satisfied postoperative results, we shifted gradually to the collaborative team work. In May 2018, we definitely abandoned the classic single neurosurgeon approach to the purely intrasellar pituitary lesions in favor of the collaborative team work between otolaryngology and neurosurgery.

Between February 2017 and April 2018, the intraoperative outcomes of the first 50 consecutive cases of intrasellar pituitary lesions undergoing EETS were evaluated prospectively. To avoid the potential bias that may be introduced by the relative surgical experience between different surgeons in the same specialty, cases were dropped randomly into two groups (A and B) and operated mutually by single neurosurgeon in one case and as a collaborative work with a single ENT surgeon in another (Table 1). All cases with suprasellar or parasellar extensions which require extended approaches were excluded from the current study. The series consisted of 25 patients operated on completely from the start by a single neurosurgeon (group A) underwent a standard single-nostril EETS (total $n=25$ approaches) and another group of 25 patients (group B) operated on collaboratively by a single ENT surgeon, as a primary surgeon during the nasal step of surgery, and the same neurosurgeon, underwent a binostril EETS (total $n=50$ approaches).

A survey was created preoperatively by asking each surgeon about his surgical technique and anatomical landmarks used during surgery. Surgical instruments used by both surgeons were nearly the same with some instrumentation specific for each surgeon (Table 2). The intraoperative assessment was based upon recording the preoperatively settled parameters during the surgical procedure and then analyzing it postoperatively by independent third party who is the corresponding author.

Table 1 Summary of preoperative characteristics in both groups

Group data	Number
Group A	
Total patients	25
Female/male	10/15
Age (range)	49 years (18–74 years)
Type of lesion	
Pit. Macroadenoma	18
Pit. Microadenoma	6
Rathke's cleft cyst	1
Group B	
Total patients	25
Female/male	8/17
Age (range)	45 years (16–76 years)
Type of lesion	
Pit. Macroadenoma	20
Pit. Microadenoma	5

All patients from group A underwent a fully endonasal endoscopic surgery using a rigid endoscope fixed by a holder with a pneumatic powered easy control of the joints. This holder allows adjusting the endoscope during surgery, and when required, permits the surgeon to use both hands to guide the surgical instruments [7]. Neurosurgeon performed a single-nostril approach using the side contralateral to the greatest extension of the tumor (Fig. 1).

After preparation of nasal cavity with betadine-soaked cotton-tipped applicators, the nasal dissector was inserted in the same side for lateralization of middle turbinate on the side of the approach to expose adequately the sphenoidal recess. The neurosurgeon had adopted mainly on using the roof of the choana as a fixed surgical landmark with blind palpation of the anterior wall of the sphenoid sinus above the choana, between the superior turbinate and sphenoid rostrum, for reaching sphenoid ostium. Then, the posterior part of nasal septum was separated from the sphenoid rostrum followed by doing a total sphenoidotomy (removal of the whole anterior wall of the sphenoid sinus). This was always aided using the C-arm fluoroscope and image-guided surgery system along the whole procedure.

In group B, a rigid endoscope with suction–irrigation hand piece was routinely used by ENT surgeon. The posteroinferior part of the middle turbinate was lateralized to widen the space between the middle turbinate and nasal septum. The endoscope then was angled rostrally, along the roof of the choana and the sphenoidal recess for approximately 1.5–2 cm, following the posteroinferior end of both middle and superior turbinates until reaching sphenoid ostium (Fig. 2). Then, the same procedure was performed on the other side. The nasal septum was separated from the sphenoid rostrum with removal of the posterior portion of

Table 2 Surgical instruments used by the neurosurgeon and the ENT surgeon in both groups

Instrument	Group A (neurosurgeon)	Group B (ENT surgeon)
Endoscope	Rigid endoscope 30 cm in length and 4 mm in diameter with angled lenses of 0°, 30°, and 70° (Olympus, Hamburg, Germany)	Rigid endoscope 18 cm in length and 4 mm in diameter with angled lenses of 0°, 30°, and 70° (Hopkins® Telescope)
Endoscope holder	Pneumatic powered holder (Aesculap, Tuttlingen, Germany)	Not used
Suction-irrigation hand piece	Not used	Suction-irrigation hand piece with interchangeable aspiration and irrigation at the end of the endoscope (Karl Storz Clearvision® II set)
Fluoroscopy and navigation system	C-arm fluoroscope and the image-guided surgery system	Not used during nasal step
Coagulator	Monopolar bovie-suction cannula or bipolar suction cannula	Single blade bipolar coagulator
High-speed drill	Used for sphenoidotomy (Unidrive® III ECO)	Used for sphenoidotomy plus bone punches
Microdebrider	Not used	(Medtronic IPC® System)

**Fig. 1** Endoscopic set used by the neurosurgeon for the endoscopic endonasal transsphenoidal surgery (EETS)

the nasal septum (about 1.5–2 cm) to allow a wide binasal approach. Finally, a total sphenoidotomy (removal of the whole anterior wall of the sphenoid sinus) was performed. ENT surgeon had relied on multiple surgical landmarks for reaching the sphenoid sinus ostium such as the roof of the choana, the posteroinferior end of both middle and superior turbinates without blind palpation of the anterior wall of the sphenoid sinus and without using fluoroscopy.

Intraoperative assessment of surgical approaches from both groups was analyzed regarding; the operative technique with specific focusing on surgical landmarks and instrumentation used by each surgeon, the average time of EEA to sphenoid sinus that ended by adequate sphenoidotomy, the endonasal difficulties (defined as any structural variants or abnormalities hindering and obscuring the direct access to sphenoid sinus), and the intraoperative endonasal

**Fig. 2** Endoscopic set used by the ENT/neurosurgeon team for the endoscopic endonasal transsphenoidal surgery (EETS)

complications including: nasal bleeding from the posterior septal branch of sphenopalatine artery, nasal septum and middle turbinate complications mainly septal perforation and flail middle turbinate.

Results

Both groups differed significantly as to intraoperative assessment; average time of the procedure was significantly shorter in group B than group A (a mean 10 vs 22 min, respectively, $P < 0.001$). Incidence of intraoperative nasal complications was higher in group A than group B (28% vs 4.8%, respectively, $P = 0.006$).

The two groups differed as to the average time for EEA to sphenoid sinus. It was shorter in group B (9.8 ± 7.8 min with

range: 4–30 min) than group A (22 ± 6.4 min with range: 12–35 min). EEAs with non-obscured sphenoid ostium were straightforward and more rapid. An additional time was required for correction and management of structural variants and abnormalities in both groups.

Endonasal structural difficulties were observed in 12 (48%) sphenoid sinus approaches from group A and 35 (83%) approaches from group B (Table 3). Interestingly, in some approaches, the nasal cavity was identified as possessing 2 or 3 structural variants and/or abnormalities on the same side. Structural variants were in the form of deviated septum, spina septi, and concha bullosa, while nasal polyps and hypertrophied inferior turbinates represented structural abnormalities. Other structural variants such as paradoxical middle turbinate, Onodi cells, and pneumatized posterior nasal septum were not recorded in the current series.

Some forms of surgical correction for such structural variants and abnormalities had to be performed by both surgeons to allow a sufficient access to sphenoid sinus. Septoplasty, due to septal deviation, was performed four times by the ENT surgeon, but never by neurosurgeon. Once, an obstructing spina septi was submucosally resected by the ENT surgeon, while it was drilled off using a diamond high-speed drill by the neurosurgeon, in one approach, resulting to opening of the septal mucosa. Because of bullous middle turbinate, partial removal was performed by the neurosurgeon in one approach, whereas a precise lateral lamellectomy, removal of the lateral part of middle turbinate, was performed by the ENT surgeon in another approach. In a total 5 approaches, endonasal polyps obscuring sphenoidal recess were debrided by the ENT surgeon, while it was simply avulsed by the neurosurgeon in two approaches. Hypertrophied inferior turbinate did not hinder the flow of the surgical approach to sphenoid sinus in both groups.

In endoscopic approaches possessing endonasal structural variants ($n = 12$ and $n = 17$ in groups A and B, respectively), the neurosurgeon performed some forms of surgical corrections in 8% of approaches, while it was performed in 14.3% of approaches by the ENT surgeon. In the other approaches which intercepted by structural endonasal variants; the ENT surgeon and neurosurgeon succeeded to complete the procedure without any surgical corrections.

Table 3 Structural difficulties in both groups

	Group A	Group B
Deviated septum	10	9
Spina septi	3	10
Concha bullosa	1	3
Polyps	2	5
Hypertrophied inferior turbinate	6	10

Intraoperative nasal complications strictly related to the EEA to sphenoid sinus in both groups were limited to bleeding from the posterior septal branch of sphenopalatine artery (SPA), flail middle turbinate, and nasal septum complications. Intraoperative bleeding, due to injury of the posterior septal branch of SPA, was recorded in 5 (20%) approaches from group A, was controlled by endoscopic targeted cautery using either monopolar or bipolar suction cannula, while it was documented in 2 (4.8%) approaches from group B and controlled by single blade bipolar coagulator.

In group A, opening of septal mucosa occurred in one approach during drilling off spina septi and flail middle turbinate; in another approach, following partial removal of a concha bullosa. Similar endonasal complication never occurred in group B.

Discussion

Sphenoid sinus is a large paired paranasal sinus located posterior to the ethmoid sinuses [5]. Due to its anatomical location, endoscopic endonasal approach (EEA) to sphenoid sinus remains a valuable procedure for both neurosurgeon and ENT surgeon. The use of endoscopes in neurosurgery had a diverse evolution than its use in otolaryngology [8]. Endoscope was first used as the only visualizing tool in skull base surgery for pituitary lesions in the early 1990s [8, 9] with the collaboration of otolaryngologists and neurosurgeons [10–12].

Endoscopic endonasal transsphenoidal approaches require abundant collaborative work between the neurosurgeon and the ENT surgeon [5]. Since the neurosurgeon may be confronted with endonasal difficulties (structural variants or abnormalities) and complications during EEA to sphenoid sinus, a collaborative work with the ENT surgeon is highly recommended for such approaches. Thus, the current study was conducted to evaluate whether endonasal difficulties and complications related to the EEA to sphenoid sinus pose any difference for the neurosurgeon and the ENT surgeon performing the same surgical procedure.

The endoscopic endonasal approach (EEA) to sphenoid sinus is straightforward and can be performed within 10–15 min [6]. This was compared to a mean of 10 and 22 min by ENT surgeon and neurosurgeon, respectively, in the current series. The frequent checking of nasal anatomical landmarks by fluoroscopy used by the neurosurgeon may prolong the surgical procedure. Non-obscured sphenoid sinus ostium allows rapid approach to the sinus; however, endonasal structural variants or abnormalities may represent an obstacle for the direct access to sphenoid sinus. Indeed, the stepwise approach to sphenoid sinus used by the ENT surgeon has posed the benchmark for more adequate and rapid identification of the sphenoid sinus ostium.

Judgment of a structural variation is very subjective and there are also differences in its definition [6, 13]. It is defined as any anatomical detail of the nose that obscures the direct endoscopic view of the anterior sphenoid wall [6]. Zinreich [14] recorded at least one structural variant in about 62% of patients presented with chronic sinusitis, while in the normal population, this appeared only in 13%. Bolger et al. [13] recorded bony endonasal variants in 65% of patients and mucosal abnormalities in 41.7% of patients. In general, structural variants commonly seen in the nasal cavity include deviated septum, concha bullosa [15] and a spina septi as a separate entity [6]. In our series, deviated septum was the commonest structural variant in the neurosurgical approaches. Hypertrophied inferior turbinate was the commonest mucosal abnormality, in the rhinological approaches, while spina septi and deviated septum were the commonest bony variants.

Although endonasal structural variants were frequent in the ENT approaches ($n = 17$, 40.5%), it did not represent a relevant obstacle for the ENT surgeon as it did for the neurosurgeon. When the direct EEA to sphenoid sinus was completely hindered ($n = 5$), structural variants were precisely corrected by the ENT surgeon particularly the ones requiring high surgical skill such as deviated septum, spina septi, and concha bullosa. However, the neurosurgeon has not been accustomed to deal with such nasal variants, particularly and the challenging ones such as deviated septum and concha bullosa [16].

Intraoperative bleeding during EEA to sphenoid sinus may be minor coming from the small arterioles of the nasal mucosa or brisk bleeding due to injury of the posterior septal branch of SPA. In the current series, injury of the septal branch of SPA was encountered in five neurosurgical approaches (20%), while it was recorded in only two ENT approaches (4.8%). The risk of damaging the septal branch of SPA is potentially higher when the sphenoidotomy is made in the inferior lateral or downward direction [17]. Cauterization of the inferior aspect of the anterior sphenoid wall [4] with or without lateral displacement of the mucosa before bone removal [17] remains the best way to avoid injury of this artery.

Conclusion

EETS is not a one man show, but it needs constant collaboration between the neurosurgeon and the ENT surgeon even, for straightforward trans-sellar approaches. Endonasal structural variations have a practical significance during endoscopic endonasal approaches, so the preoperative assessment of these variations and how to precisely manage is important for minimizing the potential for perioperative surgical complications. Furthermore, the stepwise surgical approach

to sphenoid sinus has demonstrated the significance of collaborative intervention into such surgical approaches of challenging anatomy.

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Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments.

Informed consent Informed consent was obtained from all individual participants included in the study.

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