Minimizing Septectomy for Endoscopic Transsphenoidal Approaches to the Sellar and Suprasellar Regions: A Cadaveric Morphometric Study

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Abstract

The purpose of this study was to evaluate the effect of posterior septectomy size on surgical exposure and surgical freedom during the endoscopic transsphenoidal approach to the sella and parasellar region. Dissections were performed on 10 embalmed cadaver heads. Dissections started with wide bilateral sphenoidotomies, lateralization of middle turbinates, and a 5-mm posterior septectomy. The posterior septectomy was increased in 5-mm increments to a maximum of 35 mm, followed by bilateral middle turbinectomies. Surgical exposure was defined as the distance between the ipsilateral and contralateral limit of exposure as allowed by the posterior septum along a midsphenoid horizontal meridian. Surgical freedom was defined as the angle between the ipsilateral and contralateral limit. The mean baseline width of the posterior sphenoid sinus was 29.4 ± 3.7 mm. With a 5-mm septectomy, the mean width of surgical exposure was 21.1 ± 2.8 mm. The surgical exposure increased significantly with progressively larger posterior septectomy until a 20-mm posterior septectomy, after which no further increase in surgical exposure or freedom was obtained. Bilateral lateral opticocarotid recesses were accessible with a 15-mm posterior septectomy. The addition of bilateral middle turbinectomies did not significantly increase lateral exposure within the sphenoid sinus compared with middle turbinate lateralization.

Keywords

- endoscopic
- endonasal
- transnasal
- transsphenoidal
- septectomy
- middle turbinectomy
- sinonasal quality of life

Introduction

The endoscopic endonasal approach (EEA) has offered an alternative to microscopic transnasal and transcranial approaches to the sella, suprasellar region, and anterior skull base. Since the first publications of purely endoscopic resections of pituitary tumors by Jankowski et al, Jho and Carrau and coworkers^{1–4} the EEA has expanded to include pathology from the frontal sinus to

the cervical spine, and laterally to the infratemporal fossa.^{5–8} Studies have documented that the EEA is safe and effective, and may offer less morbidity in select cases with quicker recovery.^{9,10} The EEA offers wider visibility over microscopic techniques and avoids the frontal lobe retraction often required for transcranial approaches. However, excessive removal of the nasal structures can lead to poor sinonasal functional outcomes that can significantly impact quality of life (QOL).^{11–13}

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For pathology requiring a transsphenoidal approach, a posterior septectomy is performed to provide binarial access through the sphenoid sinus. In addition, unilateral or bilateral resection of the middle turbinates has been advocated for additional working space.^{5,6} However, the amount of surgical exposure and surgical freedom obtained by resection of these nasal structures has not been previously determined in a quantitative manner. The purpose of this study was to determine the extent of posterior septectomy necessary to gain adequate access to the sphenoid sinus and sella. Additionally, we sought to determine whether middle turbinate resection increased surgical exposure or surgical freedom at the posterior sphenoid sinus compared with middle turbinate lateralization.

Materials and Methods

Study Materials

We obtained 10 embalmed, latex-injected, cadaveric heads free from any head and neck disease. Screw skull fiducials were placed and thin-slice (1.0 mm) sinus computed tomography scans were performed for stereotactic navigation. Each cadaveric head was placed in rigid fixation and image registration was performed to less than 2 mm deviation error and confirmed with anatomical landmarks. Dissection was performed using a 4-mm, 0-degree, rigid endoscope with high-definition monitor and camera (Stryker, Kalamazoo, Michigan, United States), as well as standard endoscopic instrumentation. Neuronavigation software (Stryker) and a 15 cm stereotactic navigation probe were used to obtain measurements. Our study was designed to simulate a standard binarial EEA to the sphenoid sinus and sella.

Dissection and Measurements

The inferior and middle turbinates were lateralized bilaterally. A wide sphenoidotomy was performed bilaterally, to the limit of the medial orbit and from the planum sphenoidale to the floor of

the sphenoid sinus. Sphenoid septations were removed and key anatomical landmarks were identified for the measurements. We obtained two baseline measurements—sphenoid sinus width and inter-opticocarotid recess (OCR) distance—to serve as a control for each cadaveric specimen. Using stereotactic navigation, the distance was measured between the lateral extents of the sphenoid sinus exposure through each corresponding naris, and is labeled the maximum horizontal exposure width (max-HEW) (►Fig. 1). For consistency, all measurements were taken along a horizontal meridian defined as the midpoint between the tuberculum sella and the floor of the sphenoid sinus. Typically, this line approximated the junction between the sellar floor and clival recess.

We then measured the surgical exposure after varying degrees of septectomy. Surgical exposure was defined as the distance (in mm) between the ipsilateral limit of exposure of the sphenoid sinus to the contralateral limit of exposure as permitted by the remaining nasal septum (►Fig. 2). After each incremental septectomy, measurements were performed in each naris, thus providing 20 sets of measurements among the 10 cadavers. Surgical exposure was measured after incremental posterior septectomies, performed at 5-mm intervals to a maximum of 35 mm (►Fig. 2).

We also measured surgical freedom, defined as the angle between the ipsilateral and contralateral limits of exposure. To calculate this angle, the distances between the pyriform aperture and the ipsilateral and contralateral limit were measured (►Fig. 2) to calculate surgical freedom (SF) in degrees according to the following formula:

$$SF = \cos^{-1} (a^2 + b^2 - c^2) / 2ab$$

As a final step after 35-mm septectomy, bilateral middle turbinectomies were performed and surgical exposure and surgical freedom measurements were repeated. To better study the effect of middle turbinate resection independent

Fig. 1 Baseline measurements. Coronal view of the posterior sphenoid sinus wall with key anatomical landmarks. The two baseline measurements taken for each cadaveric specimen were maximal horizontal exposure width (max-HEW) and the distance between both lateral opticocarotid recesses (inter-OCR distance). All measurements were taken along a horizontal meridian defined by the midpoint (red x) between the tuberculum sella and sphenoid sinus floor, which typically corresponded to the level of the sellar floor.

Fig. 2 (A) Measurements taken after 5-mm septectomy. Surgical exposure was defined as the distance c (yellow arrow) between the ipsilateral horizontal limit and the contralateral horizontal limit, as allowed by the posterior septum. Surgical freedom was approximated by calculating the angle (θ), after determining the distance between the pyramidal aperture and ipsilateral and contralateral horizontal limits (dotted lines a and b). (B) Measurements repeated after a 20-mm septectomy.

of posterior septectomy extent, surgical exposure measurements after middle tubinectomy were taken in a similar fashion to the baseline max-HEW measurement (i.e., lateral limit taken from ipsilateral nostril and contralateral limit taken from contralateral nostril).

All measurements were made under direct visualization with the endoscope inside the corresponding naris. Surgical exposure and freedom were defined solely in a horizontal plane because in the transsphenoidal approach through a given naris, the posterior septum and middle turbinate primarily impede access in the horizontal plane rather than in the vertical plane. Limiting measurements to a single plane also increased consistency and reproducibility of measurements.

Analysis and Statistics

A two-sided paired *t*-test (JMP, Cary, North Carolina, United States) was used to compare surgical exposure and freedom after each incremental posterior septectomy to the prior surgical state (e.g., 10 vs. 5-mm septectomy). Because each specimen served as its own control, interspecimen variability was addressed. We determined the extent of posterior septectomy beyond which no significant increase in exposure or surgical freedom of the sphenoid sinus occurred. A two-sided paired *t*-test was also used to compare surgical exposure and freedom between middle turbinate lateralization and resection. A *p* value < 0.05 was considered statistically significant.

Results

Exposure with Septectomy

As demonstrated in ►Table 1, the surgical exposure and freedom increased after the initial posterior septectomy. Increasing from 5 to 20 mm of posterior septectomy, surgical exposure increased from 21.1 ± 2.8 to 28.7 ± 3.2 mm, and surgical freedom increased from 16.3 ± 2.5 to 23.3 ± 3.0 degrees. No significant increase occurred in surgical exposure or freedom with additional septectomy beyond 20 mm (►Fig. 3). Of note, surgical exposure equivalent to the mean inter-OCR distance was achievable with a septectomy of 15 mm.

Middle Turbinectomy

After removal of bilateral middle turbinates, surgical exposure and freedom were 29.6 ± 3.3 mm and 24.4 ± 2.7 degrees,

Fig. 3 (A) Surgical exposure (mm) and (B) surgical freedom (degrees) after incremental posterior septectomy. inter-OCR, distance between lateral opticocarotid recesses; max-HEW, maximum horizontal exposure width baseline measurement.*Indicates statistically significant increase compared with the prior surgical condition.

respectively (►Fig. 4; ►Table 2). There was no significant increase of surgical exposure or freedom (*p* = 0.90 and 0.82) by adding middle turbinectomies compared with middle turbinate lateralization.

Discussion

Resection of the posterior septum and middle turbinates has been frequently advocated for better surgical access during EEAs to sellar and parasellar lesions.^{5,6} However, aggressive resection of these structures may add significant rhinological morbidity.^{10–16} In addition to binarial access to the sphenoid

Table 1 Mean surgical exposure and freedom with progressive septectomy

Septectomy (mm)	Surgical exposure (mm ± SD)	<i>p</i> Value	Surgical freedom (degrees ± SD)	<i>p</i> Value
5	21.1 (2.8)		16.3 (2.5)	
10	23.4 (2.7)	< 0.001	18.9 (2.4)	< 0.001
15	26.1 (3.5)	< 0.001	21.2 (3.2)	< 0.001
20	28.7 (3.2)	< 0.001	23.3 (3.0)	< 0.001
25	28.6 (3.0)	0.845	23.5 (2.5)	0.298
30	28.8 (3.1)	0.159	23.8 (2.7)	0.158
35	29.1 (3.2)	0.282	24.3 (3.0)	0.197

Abbreviation: SD, standard deviation.
Note: Values given in bold represent statistically significant values.

Fig. 4 Comparison of surgical exposure (A) and surgical freedom (B) between middle turbinate lateralization and resection. MT, middle turbinate.

sinus, a posterior septectomy permits instrument access to the contralateral side and may improve maneuverability within the sphenoid sinus (i.e., reaching the left OCR with instruments entering the right nare). The middle turbinate might limit access to the lateral recess of the ipsilateral sphenoid sinus and possibly limit the lateral working space through the ipsilateral naris. In our surgical experience, middle turbinate lateralization has been employed without impaired exposure or maneuverability. The impact of posterior septectomy and middle turbinectomy on sphenoid sinus exposure and surgical freedom has not previously been evaluated in the literature.

Using 0-degree endoscopes, our results demonstrate that maximal exposure of the sphenoid sinus was achieved in all specimens with a posterior septectomy of 20 mm. Beyond 20 mm, no further increase in exposure or surgical freedom was gained. Furthermore, bilateral exposure of the lateral OCRs was achieved in all specimens following a septectomy of 15 mm, suggesting that sufficient working exposure for the majority of sellar and parasellar pathologies may be achieved with a 15-mm posterior septectomy. This is to our knowledge the first quantitative measurement to support that a small posterior septectomy will provide sufficient access to the posterior sphenoid sinus wall and sella. Middle turbinate

resection (with a posterior septectomy of 35 mm) also failed to result in further increases in exposure or freedom compared with middle turbinate lateralization. Our data suggest that when accessing the lateral portions of the sphenoid sinus through the ipsilateral nares (i.e., the right lateral OCR through the right nare), middle turbinate resection may not add significant exposure over lateralization.

Although the results obtained in this cadaveric study were highly consistent, there are limitations to this study. First, we did not assess the impact of middle turbinate removal on the maneuverability of multiple instruments in the same nostril, so interpretation of our results is made with caution. Also, we did not study the impact of middle turbinate resection on surgical exposure and freedom with a posterior septectomy less than 35 mm. Second, differences in tissue pliability between embalmed cadaveric specimens and actual patients may affect measurements. However, one would expect decreased tissue pliability of the cadavers to more greatly reduce surgical exposure and freedom obtained with septum and turbinate preservation. Additionally, while these results are most likely relevant when using zero degree endoscopes and straight instruments, the use of angled instruments or endoscopes may allow adequate exposure of the sphenoid sinus and sella with even smaller septectomy and less tissue disruption. Individual anatomic factors including septal deviation, location of pathology, and shape of the sphenoid sinus also need to be considered to tailor the exposure.

Recently, studies analyzing QOL after endoscopic skull base surgery show that there is an initial postoperative worsening of sinonasal QOL, which gradually returns to preoperative baseline by 6 to 12 weeks.^{10,13} One prior study found the middle turbinate preservation rather than resection resulted in a faster return to preoperative sinonasal outcome test scores.¹⁵ The literature is replete with good data on the clinical implications of variations in size of posterior septectomy, especially in the setting of skull base surgery. However, crusting and anosmia are two sinonasal QOL issues that are often affected and techniques to minimize

Table 2 Comparison of mean surgical exposure and freedom between middle turbinate lateralization and resection

Exposure	MT lateralization	MT resection	<i>p</i> Value
Surgical exposure (mm)	29.4 ± 3.7	29.6 ± 3.3	0.90
Surgical freedom (degrees)	24.2 ± 2.8	24.4 ± 2.7	0.82

Abbreviation: MT, middle turbinate.

Note: Measurements for middle turbinate lateralization versus resection were made after a 35-mm posterior septectomy.

these complications are important. Anosmia is rarely seen after simple sphenoidotomies, yet it is more common after the EEA approach to the sella and this may be related to trauma to the posterosuperior nasal septum. Another important sinonasal complication is empty nose syndrome (ENS), an iatrogenic disorder most often recognized by the presence of paradoxical nasal obstruction despite an objectively wide nasal fossa.¹⁴ It has been described as a secondary form of atrophic rhinitis, although some authors consider it a distinct entity occurring after resection of middle and inferior turbinates and septum in endoscopic sinus surgeries.¹² Given the significant effect on QOL and difficulty in treatment, efforts to reduce the potential for ENS should be considered such as limiting the resection of normal sinonasal structures. Although this study does not directly explore a correlation between these various sinonasal complications and extent of septectomy or middle turbinectomy, limiting resection of normal sinonasal structures might result in the least postoperative rhinological morbidity and most rapid recovery of sinonasal QOL.

Conclusions

A posterior septectomy of beyond 20 mm did not significantly increase surgical exposure or freedom of the posterior sphenoid sinus and sella. In fact, posterior septectomy of 15 mm was sufficient for exposure of bilateral OCRs. Compared with middle turbinate lateralization, middle turbinectomy did not add any significant surgical exposure or freedom from the ipsilateral naris. The true impact of middle turbinectomy on instrument maneuverability requires further study.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this article.

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