Rhinologic Evaluation of Patients Undergoing Transsphenoidal Surgery

7

Michael Freeman, Jose Gurrola II, and Spencer C. Payne

Historical Perspective

The first documented transsphenoidal approach to the pituitary gland was in 1907, when Hermann Schloffer introduced the transnasal transsphenoidal approach [1, 2]. Three years later, Harvey Cushing modified a translabial surgery created by Halsted and Kocher to pioneer the sublabial transsphenoidal approach to the pituitary [2, 3]. In the 1990s, the widespread adoption of rigid endoscopy allowed for microscopic sublabial approaches to be abandoned in favor of transcolumellar approaches without compromising retraction or surgical site visibility [4–8]. In the ensuing years, the sublabial and transcolumellar approaches have been found to have similar complication rates, but the endoscopic transnasal approach to transsphenoidal surgery has demonstrated superior surgical resection [7–9].

Prior to the advent of endoscopic transsphenoidal surgery, the role of otolaryngology was largely limited to outlining anatomic concerns regarding the sphenoid sinus. As endoscopy increasingly becomes the de facto approach to transsphenoidal surgery, obtaining a sufficient view of the operative field often justifies turbinectomy, septectomy, or septoplasty. As otorhinolaryngologists are experts in these procedures, both their assistance in the operating room and a thorough preoperative otorhinolaryngological evaluation have become relevant to transsphenoidal surgical outcomes.

M. Freeman
University of Virginia School of Medicine, Charlottesville, VA, USA

J. Gurrola II
Department of Otolaryngology, Head & Neck Surgery, University of Virginia School of Medicine, Charlottesville, VA, USA

S.C. Payne (✉)
Department of Otolaryngology, Head & Neck Surgery, Division of Allergy & Clinical Immunology, University of Virginia School of Medicine, Charlottesville, VA, USA
e-mail: SCP9X@hscmail.mcc.virginia.edu

E.R. Laws, Jr. et al. (eds.), *Transsphenoidal Surgery*,
DOI 10.1007/978-3-319-56691-7_7

Nasal Functions and Physiology

The nose primarily functions to humidify and warm incoming air, remove airborne particulates, engage the sense of smell, and allow unobstructed passage of air. The importance of these nasal functions is supported by quality of life assessments in patients with chronic nasal obstruction, nasal valve collapse, anosmia, and empty nose syndrome. The preservation of nasal structures and mucosa is important in maintaining nasal airflow and comfort. Otolaryngologists often assist in the approach to the sphenoid sinus to maximize exposure while limiting rhinologic complications.

Paranasal Sinus Function and Physiology

The exact function of the paranasal sinuses is uncertain. Some have theorized that, without the pneumatization of the facial skeleton that results in the formation of the sinuses, the weight of the head would be too great. However, given the large head to body size ratio of children, this postulate is less likely. Others have also suggested that the sinuses serve to insulate intracranial structures with air, similar to the properties of double-paned glass. In truth, the most widely accepted and putatively logical explanation of the sinuses is that they serve as a "crumple zone" and prevent transmission of force to the orbital and intracranial contents in the event of blunt trauma. This has been supported by the works of several authors [10, 11]. The mucosa of the nasal cavity and sinuses is the same pseudostratified columnar epithelium that lines the respiratory tract, but is ectodermally derived as opposed to endodermal derivatives of the lower airway. Replete with numerous serous and mucinous glands, the nasal cavity and paranasal sinuses produce about one liter of mucus daily. As such, iatrogenic obstruction of the sinus outflow tracts can be significantly detrimental to a patient's postoperative course and quality of life.

Preoperative Considerations/Workup

Preoperative evaluation should incorporate a careful medical and surgical history, physical examination including endoscopic assessment, and imaging studies. The absence of a bleeding disorder or an anticoagulant regimen should be verified. A history of sinonasal conditions such as chronic sinusitis, rhinitis, nasal polyps, or sinonasal neoplasms such as inverted papilloma is associated with narrowing or blocking of nasal passages and increased mucosal bleeding, impairing visibility. These conditions often necessitate more aggressive displacement or outright resection of tissue, which increases risk of complications. The presence of an active bacterial sinusitis should be medically treated with antibiotics prior to surgery to reduce the risk of infection tracking into the surgical site. It is also important to avoid nasal packing in cases of active sinusitis. If an otolaryngologist is present to assist with the approach, surgery for many sinonasal conditions can be performed concomitant to the approach for the transsphenoidal surgery. Nasal endoscopy is helpful in determining the severity of these conditions and is of heightened importance in patients

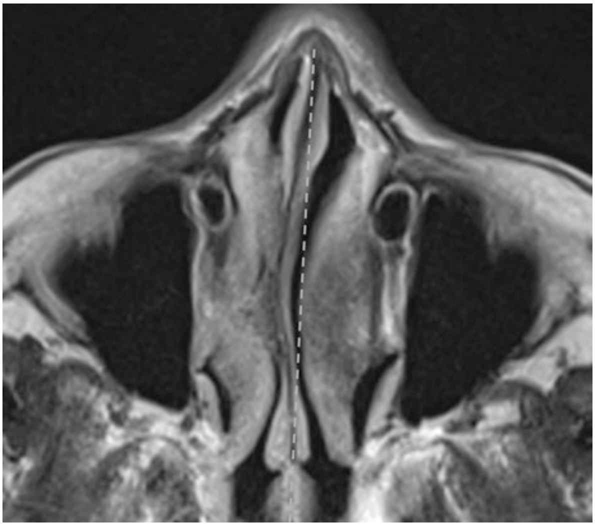

Fig. 7.1 Septal deviation. Often visible on axial MRI sequences. This image demonstrates deviation of the bony septum from midline (*dashed line*) with spurring to the patient's right side

complaining of recurrent infection, obstruction, congestion, rhinorrhea, postnasal drip, or recurrent epistaxis.

A detailed nasal surgical history must be elicited. Prior septoplasty or septorhinoplasty can cause scarring of the septum (especially with loss of quadrilateral cartilage) that complicates septal flap dissection and elevation. Prior nasal surgery can also leave synechiae (adhesions) that narrow and block nasal passages and obscure the approach to the sphenoid sinus.

Nasal anatomy should be evaluated at the preoperative workup, ideally via nasal endoscopy. The endoscopic view allows for visualization of posterior and anterior nasal deformities, whereas the nasal speculum examination is limited to the anterior nasal vault. This is paramount when intranasal surgery has already been performed, but it is less valuable in the absence of surgical history. Internal nasal anatomic variants can complicate the approach to the sphenoid, especially in the posterior nasal cavity. A common variant, especially contralateral to a concomitant septal deviation, is the pneumatization and enlargement of the middle turbinate. Termed a concha bullosa, the presence of this structure can complicate either the lateralization or resection of the middle turbinate during an endoscopic approach. Failure to recognize and address a concha bullosa may increase the probability of iatrogenic osteomeatal complex obstruction and subsequent sinusitis. Another common variant is the sphenoethmoidal (aka Onodi) air cells. These can be identified pathognomonically on coronal view radiologic images when horizontal septations are seen within the sphenoid sinus. A complete opening of the sphenoid and visualization of the sella can be significantly hampered if these cells are not addressed.

Septal deviation seen on preoperative workup can dictate the operative approach and justify/require intraoperative septoplasty (Fig. 7.1). Generally, spurs or significant deflections at the level of the lower portion of the middle turbinate will necessitate correction. Further, understanding the shape of a deviated septum can help in

Fig. 7.2 Saddle nose deformity. This usually indicates a destructive process and likely lack of underlying cartilaginous septum. Further workup is necessary

planning for a nasoseptal flap elevation that may be required for skull base reconstruction. It is far easier to elevate a flap from the concave side of a septal deflection, but if that side also involves a septal spur, the dissection will be delicate and require significant skill to prevent incidental tearing. Septal perforation present before surgery can also pose a challenge. Depending on the location of the perforation, the maximal length or width of any planned mucosal flap may be diminished. Furthermore, if the surgical plan includes a posterior septectomy, as is the standard at the authors' institution, a significant increase in the size of the perforation and a change in nasal symptoms can occur. Risk factors for septal perforation should be elicited during the preoperative evaluation and include prior nasal trauma, prior septal surgery, intranasal cocaine use, and/or autoimmune conditions such as granulomatous polyangiitis (formerly Wegener's granulomatosis) or sarcoidosis.

Abnormalities of the nasal pyramid and tip support structures can also complicate the surgical approach to the sphenoid. Saddle nose deformity is a condition in which the support mechanisms of the external nose fail, resulting in collapse of the midportion of the nose (Fig. 7.2). Its presence usually indicates defects in the septum, which in turn are most likely due to septal perforation (causes described above) or prior septal surgery. Saddle nose can complicate the dissection and transposition of a septal flap in the same way as septal perforation and septal scarring. Twisted nose deformity can be due to deformity of septum, nasal bones, and nasal tip cartilage and soft tissue (Fig. 7.3). Such significant external signs often predict significant internal derangements which may necessitate extra-nasal surgery at the same setting to augment the approach while facilitating optimal correction of the patient's anatomy.

Fig. 7.3 Twisted nose. Line drawn to more easily identify the deviation of the nose and underlying septum. Correction of the septum will likely require osteotomies and may be better suited as a staged procedure

A sleep history should also be obtained prior to surgery. Sleep apnea is extremely common in acromegaly, with obstructive sleep apnea occurring in 60–70% of patients and central sleep apnea occurring in about 20–30% of patients [12, 13]. Obstructive sleep apnea is also very common in patients with Cushing's disease, occurring in about one-half of patients [14]. Acromegaly and Cushing's disease are among the most common indications for transsphenoidal surgery. Because untreated sleep apnea increases operative risk, it is important to determine if a patient suffers from this disease, and if so, patients should be guided into proper preoperative intervention [15, 16].

Imaging

Preoperative imaging protocols should optimally be modified to include the nasal septum and paranasal sinuses. This can often be achieved with MRI alone and the authors find that a T2-weighted series is helpful in understanding the paranasal sinus anatomy when a bone-windowed CT scan is not available. While not a substitute for direct visualization of the septum, one retrospective evaluation of axial acquired MRI images was able to predict the need for septoplasty (unpublished data from UVA). In that series, we were able to demonstrate a 56% probability of requiring a septoplasty if the maximal septal deflection was greater than 3 mm from ideal. This increased to 93% when the deflection was greater than 5 mm. Despite this, most otolaryngologists are accustomed to visualizing nasal anatomy with coronally oriented series. As such, collaboration between neurosurgical and otolaryngologic colleagues will be necessary to define the optimal sequences that will facilitate the collection of all pertinent anatomical information. We have found that when CT angiography is performed to define the intracranial vascular anatomy, these images can completely obviate the need of any additional CT imaging of the sinuses. The narrow slice thickness typically required for these studies is a superb adjunct for visualizing bony structures and pinpointing sinus and septal anomalies. The results of the imaging can determine the role of intraoperative stereotactic image guidance.

Postoperative Rhinologic Evaluation

The rhinologic evaluation of the postoperative patient is tailored to the patient's procedure and any preexisting conditions that may have been corrected or potentially exacerbated during surgery. An informal review of practice patterns at a recent international educational conference indicated wide variability in the frequency of scheduled follow-up visits. At our institution, we prefer to see patients between 2 and 4 weeks after surgery if any adjunctive procedures were performed and from 4 to 8 weeks postoperatively for any straightforward sellar approaches without local flap reconstructions. At each of these visits, the potential complications of endonasal skull base surgery are surveyed including issues with epistaxis, cerebrospinal fluid (CSF) leak, and worsened or iatrogenically induced sinusitis.

Intraoperative bleeding is a common complication of transsphenoidal surgery. The endoscopic approach often necessitates blind introduction of instruments into the surgical field, which can increase the risk of intranasal trauma and mucosal bleeding. The turbinates and septum are at particularly high risk for trauma. Subsequent scab formation may facilitate the development of postoperative synechia or adhesions between the septum and turbinates. These synechiae can impair nasal functions such as airflow and olfaction and are ideally identified and managed early in the postoperative course before they become more fibrotic. The timing of follow-ups may need to be adjusted based on the type of surgery performed and the likelihood of synechia formation to optimize prophylactic care.

Postoperative bleeding is most likely to originate in nasal structures, and the management strategy generally depends on the location and briskness of the bleeding. More severe postoperative bleeding often arises after iatrogenic injury to the posterior nasal branch of the sphenopalatine artery. This bleeding can be managed through electrocautery or chemical cautery with endoscopic assistance followed by repacking of the nares. Nasal mucosal bleeding is common but generally less brisk than arterial bleeding. Packing the nares with Afrin-soaked pledgets for several minutes is usually sufficient to terminate the bleeding. Electrocautery can be effective if packing does not successfully terminate bleeding.

CSF leak is a significant concern in transsphenoidal surgery. Classically, it arises along the surgical site in the posterior wall of the sphenoid sinus, but it is also a concern from a rhinologic perspective given the fragility of the basal lamella attachment of the middle turbinate and the thin walls of the ethmoid roof and cribriform plate. Middle turbinectomy can generally be avoided in endonasal transsphenoidal surgery without compromising surgical view. When performed, however, this portion of the operation can be a common cause of CSF leak [17]. Minimizing surgical manipulation of the middle turbinate can prevent many CSF leaks from the anterior skull base. CSF leaks discovered postoperatively manifest as rhinorrhea and can be a life-threatening concern. Evaluation requires detailed endoscopic visualization of the ethmoid and sphenoid skull base for signs of clear rhinorrhea. This can be accomplished with the patient in forward head tilt position to optimize localization. Additionally, collecting any fluid and analyzing it for the presence of beta-2 (tau) transferrin can differentiate CSF from any retained saline from nasal irrigations. Ideally, evaluation of any postoperative rhinorrhea should be limited to those cases with continued drainage for 24–48 h after cessation of nasal saline applications.

Septal perforations arise from disruptions in the septal mucosa and can occur in the setting of tears in the septal flaps postoperatively. Small hematomas can go on to form septal perforations, especially in areas where underlying bone or cartilage has been resected. Medical management is the first line of therapy and normally consists of nasal saline sprays and other nasal moisturizers. This helps minimize symptoms but does not resolve the perforation. Surgical correction centers on the use of mucosal, mucoperichondrial, and mucoperiosteal flaps.

Postoperative sinusitis is a common rhinologic complication of transsphenoidal surgery and has been found in the sphenoid sinus of 6.2–7.5% of patients who underwent transsphenoidal hypophysectomy [18, 19]. Roughly half of these cases resolved with medical management. The remainder required endoscopic sphenoidotomy [18, 19]. In other cases, a mucocele forms in the sphenoid sinus, requiring either marsupialization of the sinus or complete resection [20]. Rarely, a superimposed infection can give rise to a pyocele [21]. This complication is rare and is surgically managed in similar fashion to sphenoid mucocele. Given the high frequency of isolated sphenoid sinusitis and/or mucocele in postoperative transnasal transsphenoidal surgery patients, a low index of suspicion and high readiness to initiate medical therapy for sinusitis is justified. Other intranasal infections can also arise after surgery, although this is rare.

Nasal crusting is a very common complaint in the postoperative period. Most cases resolve after a few months of supportive treatment with nasal sprays. Although more disruption of nasal anatomy is associated with greater crusting, the use of nasoseptal flaps does not change the severity or duration of nasal crusting [22]. In addition to nasal saline sprays or irrigations, emollients and aqueous-based gels can also be used to minimize the symptomaticity of this finding.

Generally, rhinologic complications of endoscopic transnasal transsphenoidal surgery are mild, self-limited, and subordinate to neurosurgical concerns. That said, sinonasal quality of life has been shown to temporarily decrease after transsphenoidal endoscopic surgery in a measurable fashion [23]. The decrease in sinonasal quality of life reaches a nadir approximately two weeks after surgery, but with appropriate pre- and postsurgical rhinologic evaluation and treatment, long-term sinonasal quality of life may exceed the patient's presurgical baseline [24].

References

1. Schloffer H. Erfolgreiche operation eines hypophysentumors auf nasalem wege. Wien Klin Wochenschr. 1907;20:621–4.
2. Cohen-Gadol AA, Liu JK, Laws ER. Cushing's first case of transsphenoidal surgery: the launch of the pituitary surgery era. J Neurosurg. 2005;103(3):570–4.
3. Cushing H. The pituitary body and its disorders. Clinical states produced by disorders of the hypophysis cerebri. Philadelphia: JB Lippincott; 1912.
4. Cappabianca P, Alfieri A, Colao A, et al. Endoscopic endonasal transsphenoidal approach: an additional reason in support of surgery in the management of pituitary lesions. Skull Base Surg. 1999;9:109–17.
5. Frank G, Pasquini E, Farneti G, et al. The endoscopic versus the traditional approach in pituitary surgery. Neuroendocrinol. 2006;83:240–8.
6. Jankowski R, Auque J, Simon C, et al. Endoscopic pituitary tumor surgery. Laryngoscope. 1992;102:198–202.
7. Charalampaki P, Ayyad A, Kockro RA, et al. Surgical complications after endoscopic transsphenoidal pituitary surgery. J Clin Neurosci. 2009;16:786–9.
8. Jho HD, Carrau RL. Endoscopic endonasal trans- sphenoidal surgery: experience with 50 patients. J Neurosurg. 1997;87:44–51.
9. Dehdashti AR, Ganna A, Karabatsou K, Gentili F. Pure endoscopic endonasal approach for pituitary adenomas: early surgical results in 200 patients and comparison with previous microsurgical series. Neurosurgery. 2008;62:1006–15.
10. Kellman RM, Schmidt C. The paranasal sinuses as a protective crumple zone for the orbit. Laryngoscope. 2009;119:1682–90.
11. Lee TS, Kellman RM, Darling A. Crumple zone effect of nasal cavity and paranasal sinuses on posterior cranial fossa. Laryngoscope. 2014;124(10):2241–6.
12. Grunstein RR, Ho KY, Sullivan CE. Sleep apnea in acromegaly. Ann Intern Med. 1991;115(7):527–32.
13. Fatti LM, Scacchi M, Pincelli AI, et al. Prevalence and pathogenesis of sleep apnea and lung disease in acromegaly. Pituitary. 2001;4:259–62.
14. Shipley JE, Schteingart DE, et al. Sleep architecture and sleep apnea in patients with Cushing's disease. Sleep. 1992;15(6):514–8.
15. Kaw R, Pasupuleti V, Walker E, et al. Postoperative complications in patients with obstructive sleep apnea. Chest. 2012;141(2):436–41.
16. Gupta RM, Parvizi J, Hanssen AD, Gay PC. Postoperative complications in patients with obstructive sleep apnea syndrome undergoing hip or knee replacement: a case-control study. Mayo Clin Proc. 2001;76:897–905.
17. Nyquist GG, Anand VK, Brown S, et al. Middle turbinate preservation in endoscopic transsphenoidal surgery of the anterior skull base. Skull Base. 2010;20(5):343–7.
18. Batra PS, Citardi MJ, Lanza DC. Isolated sphenoid sinusitis after transsphenoidal hypophysectomy. Am J Rhinol. 2005;19(2):185–9.
19. Lu YJ, Chang CN, Pai PC, et al. Isolated sphenoid sinusitis or mucocele: a potential complication of endonasal transsphenoidal surgery. J Neurobiol. 2009;91(1):63–7.
20. Herman P, Lot G, Guichard JP, et al. Mucocele of the sphenoid sinus: a late complication of transsphenoidal pituitary surgery. Ann Otol Rhinol Laryngol. 1998;107(9):765–8.
21. Giordano M, Gerganoc VM, Draf W, Fahlbusch R. Sphenoid sinus pyocele after transsphenoidal approach for pituitary adenoma. Pituitary. 2012;15:188–92.
22. de Almeida JR, Snyderman CH, Gardner PA, et al. Nasal morbidity following endoscopic skull base surgery: a prospective cohort study. Head Neck. 2011;33:547–51.
23. Magro E, Graillon T, Lassave J, et al. Complications related to the endoscopic endonasal transsphenoidal approach for nonfunctioning pituitary macroadenomas in 300 patients. World J Neurosurg. 2016;89:442–53.
24. Pledger CL, Elzoghby MA, Oldfield EH, et al. Prospective comparison of sinonasal outcomes after microscopic sublabial or endoscopic endonasal transsphenoidal surgery for nonfunctioning pituitary adenomas. J Neurosurg. 2016;125(2):323–33.