Chapter 14 – Sphenoid Sinus

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The sphenoid sinus is the most posterior of the paranasal sinuses. It lies in an area of the cranial base adjacent to critical neural and vascular structures and thus carries with it risk to these important structures from disease sequelae and iatrogenic complications. Because of the location of the sphenoid sinus and its drainage pathway, it is isolated from most nasal disorders. The sphenoid is therefore less often involved with acute and chronic infection, so surgeons find themselves in this location less frequently. Surgeons prefer to use image guidance to navigate in the area of the sphenoid sinus because they are less comfortable around these critical structures.

An appreciation of sphenoid anatomy is imperative for understanding safe surgical approaches to this sinus. The sphenoid sinus pneumatizes out of the ethmoid sinus, each sinus independently. Consequently, the intersinus septum is rarely in the midline, and not infrequently this septum or one of the synchondroses within the sinus attaches to the carotid artery on the lateral wall (Fig. 14-1).

Anteriorly, the sphenoid sinus communicates into the nose via its natural ostium. The anterior inferior projection of the anterior wall of the sphenoid sinus is called the rostrum, and it is contiguous with the posterior aspect of the vomer. The distance from the nasal sill to the rostrum is fairly constant at 7 cm, although gender and racial differences exist (Fig. 14-2).

The sphenoid ostium generally lies superiorly, 3 to 7 mm from the roof of the sinus. It is positioned medial to the superior turbinate and lateral to the nasal septum, and these two structures form reliable surgical landmarks (Fig. 14-3). Laterally and superiorly the sinus is bounded by the posterior ethmoid sinuses. Sinuses with extensive pneumatization can extend into the lesser and greater wings and even into the pterygoid plates with great variability (Fig. 14-4).

The sphenoid sinus is bordered laterally by the cavernous sinus, carotid artery, optic nerve, and cranial nerves III to VI. If the anterior clinoid process is pneumatized, a carotid optic recess will separate these two structures. The vidian nerve can be well seen on the floor of the sinus on coronal radiographs. Superiorly, the roof of the sphenoid sinus forms the planum sphenoidale, which makes up the portion of the midline skull base immediately posterior to the cribriform plates.

Posteriorly, the sinus is indented to a variable degree by the pituitary gland, depending on the type of sphenoid pneumatization. The posterior boundary of the sphenoid is the anterior wall of the clivus. The pons and brain stem with the accompanying midline basilar artery lie directly posterior to the highly pneumatized sinus in this location.

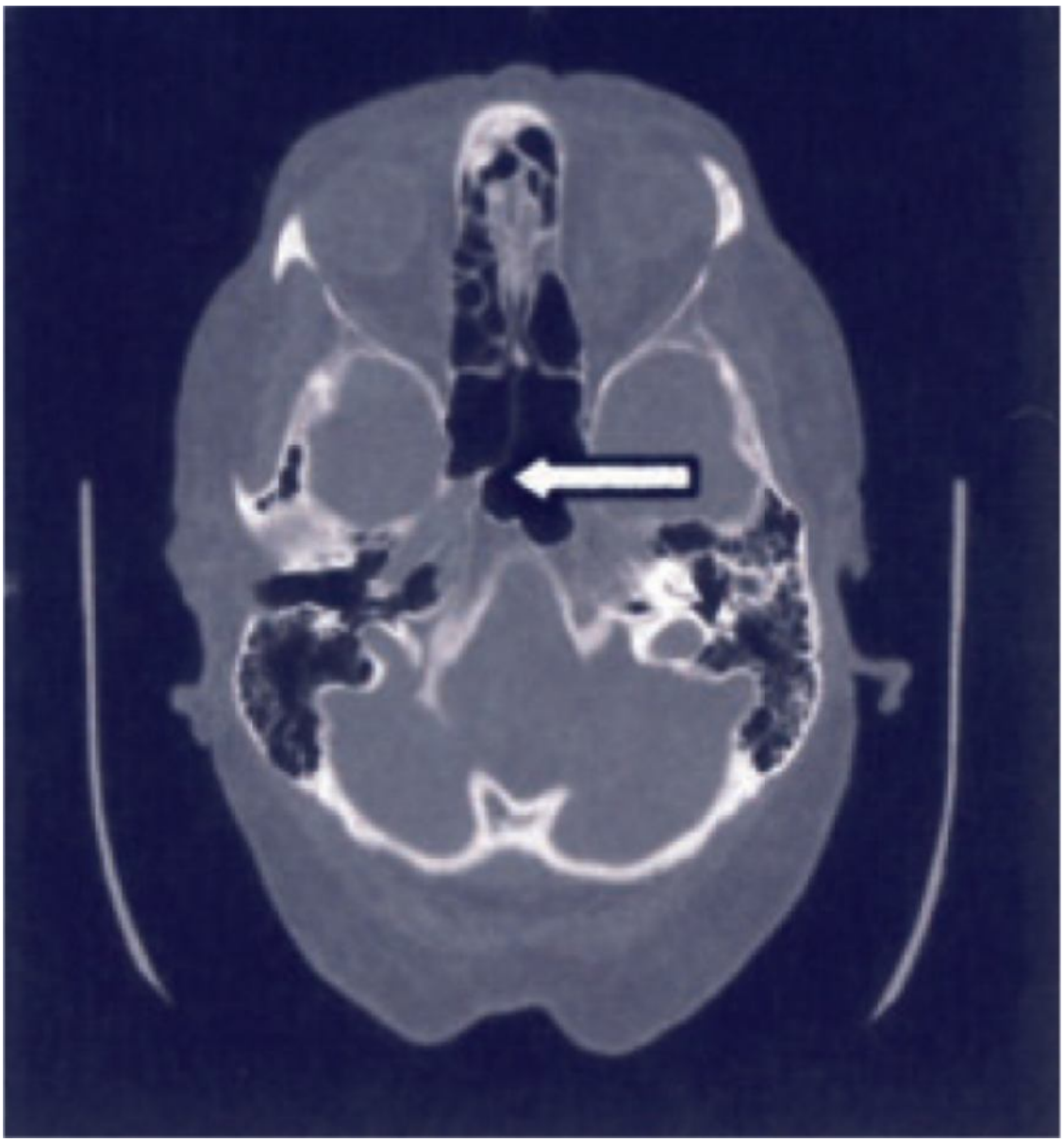

Figure 14-1 Coronal computed tomography scan with the intersinus septum attached to the right carotid artery *(arrow)*.

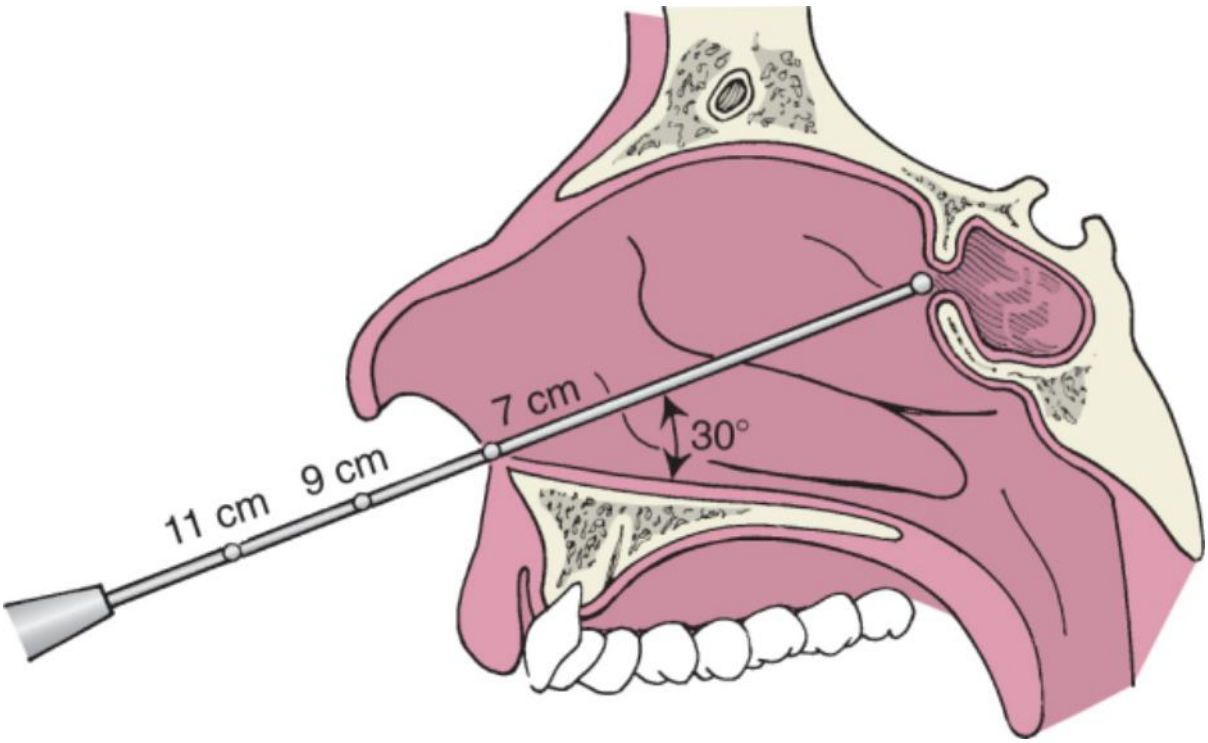

Figure 14-2 Diagram demonstrating a beaded probe anterior to the anterior wall of the sphenoid sinus.
(Redrawn from Bailey BJ: Approaches to the sphenoid. In Bailey BJ, Johnson J, Kohut R, et al [eds]: Head and Neck Surgery—Otolaryngology. Philadelphia, JB Lippincott, 1993.)

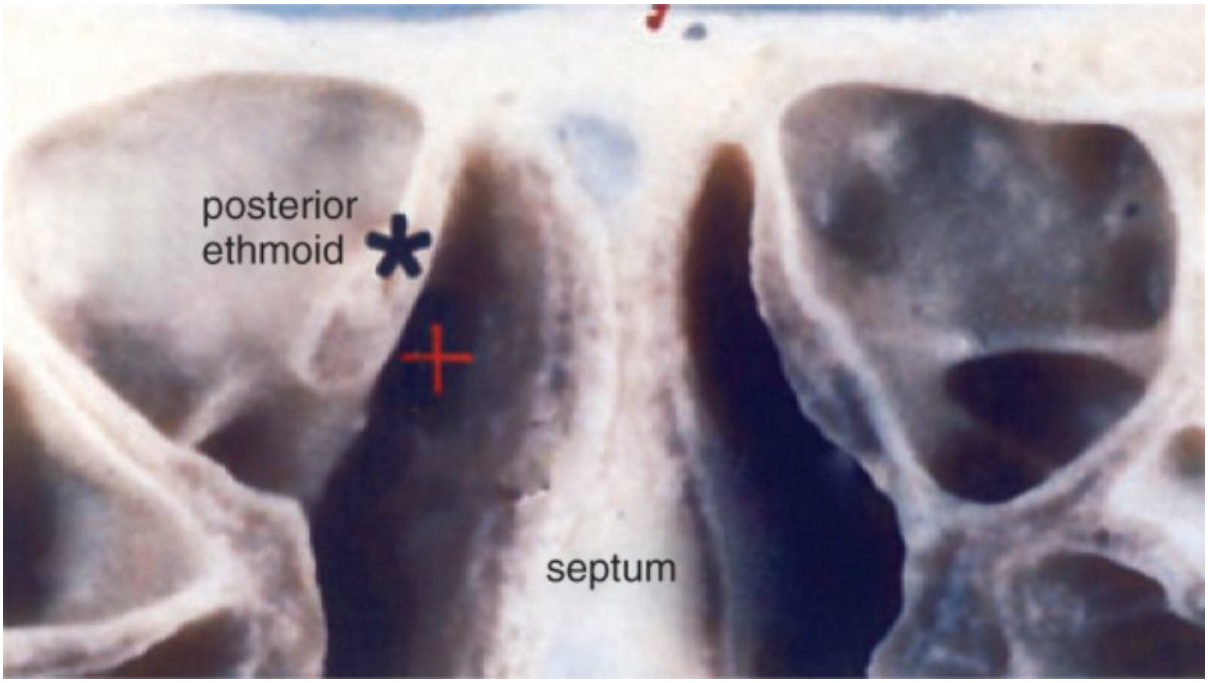

Figure 14-3 Position of the right sphenoid ostium medial to the superior turbinate. *Asterisk*, on the right superior turbinate; *plus sign*, on the right sphenoid ostium.

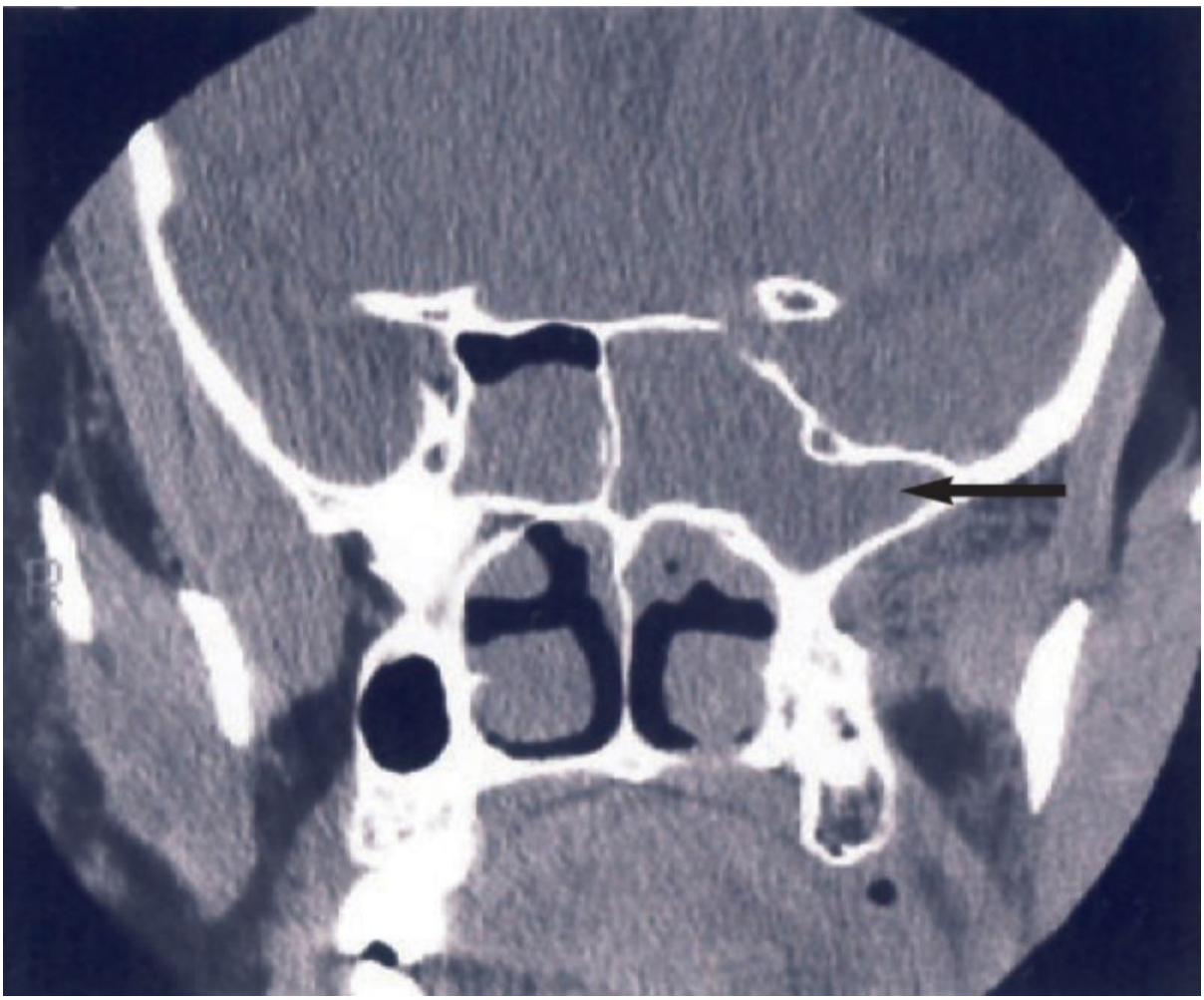

Figure 14-4 More extensive lateral sphenoid pneumatization *(arrow)*.

PATIENT SELECTION

Patients with sphenoid pathology may have no symptoms, with an abnormality noticed incidentally on imaging for a different purpose. This is particularly true of mucoceles and fungus balls. When they are symptomatic, patients may complain of a headache that is classically vertex in location. Invasive processes in the sphenoid sinus may result in dysfunction of the adjacent cranial nerves.[1,2]

Symptomatic lesions present no difficulty in surgical planning, and at least a biopsy specimen is usually obtained. It is often more difficult to handle an asymptomatic lesion. Silent lesions may require extirpation. An asymptomatic lesion that is treated nonoperatively should be monitored with subsequent imaging.

Cerebrospinal fluid (CSF) rhinorrhea can originate from within the sphenoid. Patients may have a CSF leak postoperatively as a result of bone erosion or spontaneously through congenital dehiscences in the skull base.

Definite indications for surgery include the complications of sphenoid sinusitis, expanding mucoceles, allergic or invasive fungal sinusitis, and suspected neoplasms. As with all sinuses, patients are candidates for surgery if they have failed reasonable medical therapy for inflammatory sinus disorders.

Preoperatively, patients should undergo detailed office nasal endoscopy for evaluation of the anatomic configuration and to obtain accurate endoscopic samples for culture. Computed tomography (CT) scanning is mandatory for surgical candidates and should include both axial and coronal views to document the relationship of the pathology to the optic nerve and carotid artery, with particular attention paid to the amount of bone covering the vital structures. Magnetic resonance imaging (MRI) is useful if the pathology abuts the brain or orbital contents, but it is usually complementary and not a substitute for CT.

Inflammatory disease is the most common indication for sphenoid sinus surgery. Sphenoid sinusitis usually occurs in the setting of pansinus involvement. Isolated sphenoid sinus disease is rare, but acute and chronic inflammatory disease is possible. Untreated, inflammatory disease can lead to meningitis, abscess formation, and cavernous sinus thrombosis with cranial nerve involvement or blindness.

Other diseases common to all of the sinuses can involve the sphenoid as well. Mucoceles, polyps, fungus balls, and retention cysts can develop. Benign and malignant tumors, both primary and metastatic, may occur. Both invasive and noninvasive sphenoid fungal disease can develop in immunocompetent as well as immunocompromised hosts.

Primary tumors arising within the sphenoid are very rare. However, the sphenoid sinus may be secondarily involved by extension of tumors arising outside the sinus proper, such as in the ethmoid or nasopharynx. Benign tumors of the pituitary gland may expand to involve the sphenoid sinus, and primary bone neoplasms such as osteogenic sarcoma, chondrosarcoma, or chordoma can be manifested as a mass in the sphenoid sinus. The most common malignant tumors of the sphenoid sinus are metastatic disease from the kidney, lung, and breast. Aneurysms of the basilar artery can erode into the sphenoid sinus and appear as a mass in the sinus, and aneurysms of the internal carotid artery have also been encountered.

PREOPERATIVE PLANNING

The majority of surgical procedures on the sphenoid sinus are performed either as part of endoscopic sinus surgery for chronic sinusitis or as an approach to the sella. Decisions regarding opening the sphenoid in the context of sinus surgery are complex. All the factors that weigh in on whether someone is a candidate for endoscopic sinus surgery must be considered. Preoperatively, patients should undergo thorough nasal endoscopic examination to aid in surgical planning. Careful documentation of the presence of septal or other anatomic limitations will dictate the choice of surgical options, as will the size of the sphenoid and the location of the pathology within the sinus.

Before surgery, the surgeon must select the optimal approach. In general, if performing a total ethmoidectomy, one may continue to dissect lateral to the middle turbinate as an approach to the sphenoid. In cases of isolated sphenoid disease, the surgeon may proceed medial to the middle turbinate directly to the sphenoid os (Fig. 14-5). Patients with midline pathology, such as pituitary tumors, can be approached either directly with the endoscope or by using a transseptal approach (see Chapter 103).

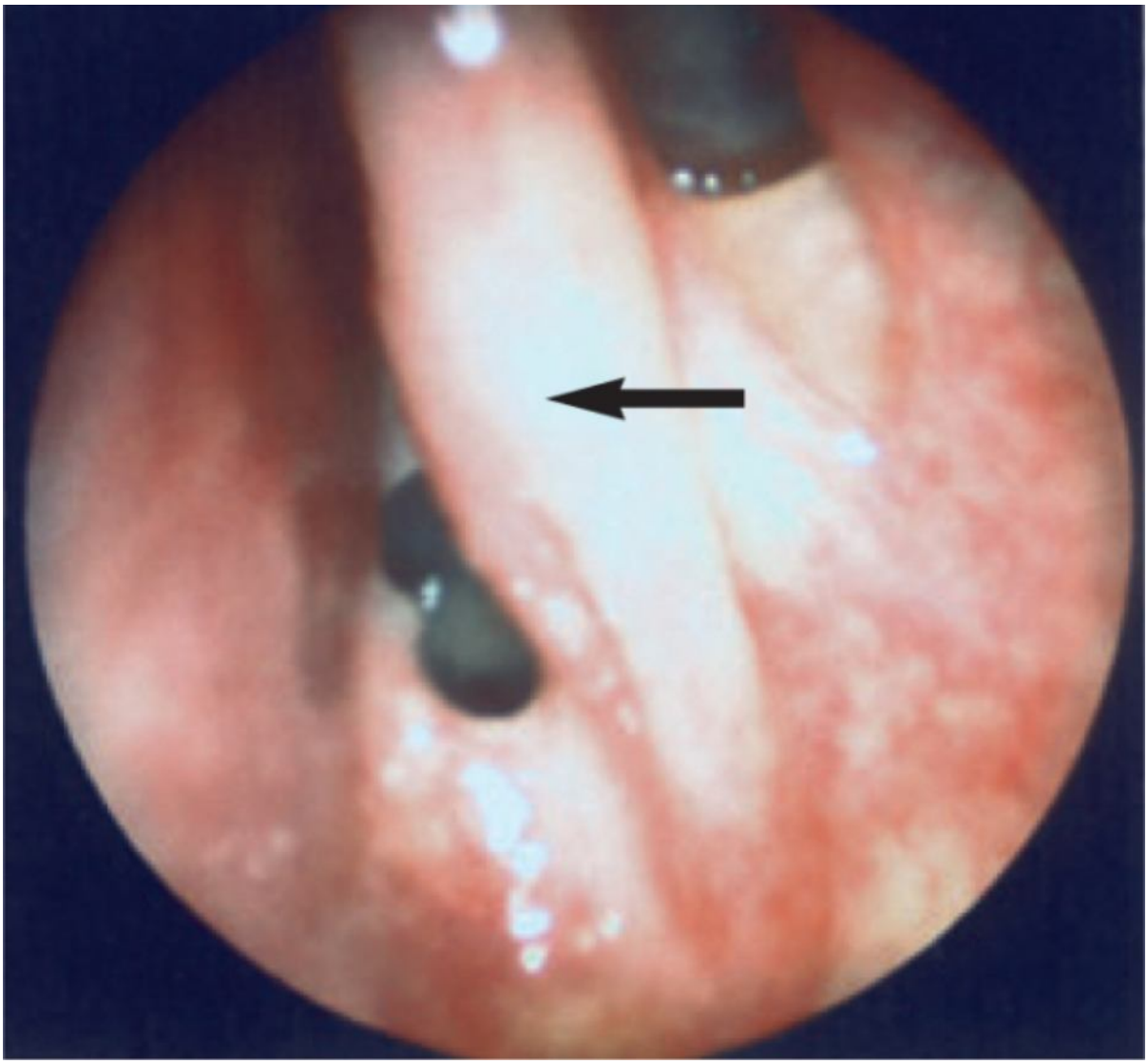

Figure 14-5 Endoscopic view of the left sphenoid ostium and superior turbinate *(arrow)*.

CT scanning is mandatory in preoperative planning. Although coronal CT is standard for all endoscopic sinus surgery, axial CT is useful for preoperative planning of sphenoid sinus surgery. At this time, computerized navigation-assisted surgery for sphenoid sinus surgery is performed on a case-by-case basis. MRI is useful if there is any question regarding the interface between the sinus and the brain or orbit, but it does not duplicate the visualization of bony detail provided by CT scans.

CT scans should be reviewed several times preoperatively and should always be displayed in the operatingroom. Particular attention should be paid to the presence of bone erosion, the location of vital structures, and the thickness of the bone covering them. The position of the intersinus septum and any incomplete bony septations should be noted. The scans should be reviewed for the presence of posterior ethmoid pneumatization that extends posterior and lateral to the sphenoid (Onodi cell formation), which puts the optic nerve at risk.

If using computerized navigation, the location of known landmarks should be confirmed before proceeding with entry into the sphenoid. There is still a use for cross-table fluoroscopy when entering the sphenoid if there is any doubt about the anatomy or if the computerized navigation instrumentation fails or is not available.

SURGICAL APPROACHES

Transseptal Approach

The transseptal route can be approached via a transnasal or a sublabial incision. The nasal approach to the septum may require the use of a limited lateral rhinotomy (alotomy), or it can proceed through an external rhinoplasty approach. We prefer the sublabial incision for transseptal surgery because of greater exposure despite the greater distance involved and the need for oral incisions.[3] This midline approach is ideal for pituitary surgery, but it is also useful for other midline pathologies when surgery on the other sinuses is not required.

Positioning of the patient depends on the procedure and surgical preferences. The nose is decongested, and local anesthesia with epinephrine is injected to hydrodissect the septal mucosa off the cartilage and bone. The sublabial area is injected if surgery will include this exposure. The eyes are left undraped in all procedures in which they might be at risk.

A headlight is required for the initial portion of the procedure. The septum is approached through a standard left anterior hemitransfixion incision, and anterior and posterior tunnels are raised on the left. These tunnels are converted into a floor-of-the-nose tunnel by sharply dividing the decussating fibers separating the two tunnels, and the left mucosal flap is completed. The cartilage is left attached to the right mucoperichondrium. The bone-cartilage junction is breeched and a posterior mucosal flap on the right is used to isolate the bony septum. The cartilage is then elevated out of the maxillary crest and the mucosa is dissected away from the floor of the nose on the right. At this point the upper lip is retracted with two army-navy retractors held by an assistant (Fig. 14-6). A gingivobuccal sulcus incision from premolar to premolar is made with electrocautery down to bone. A cuff of mucosa above the teeth must be preserved to allow closure at the conclusion of the procedure. All soft tissue is elevated off the bone and the previous nasal tunnels are entered. A small amount of soft tissue is left on the anterior nasal spine to facilitate repositioning of the septum at the conclusion of the procedure (Fig. 14-7). When coming over the piriform aperture into the floor of nose, the angulation of a Woodson elevator can facilitate this dissection and avoid tearing the mucosa.

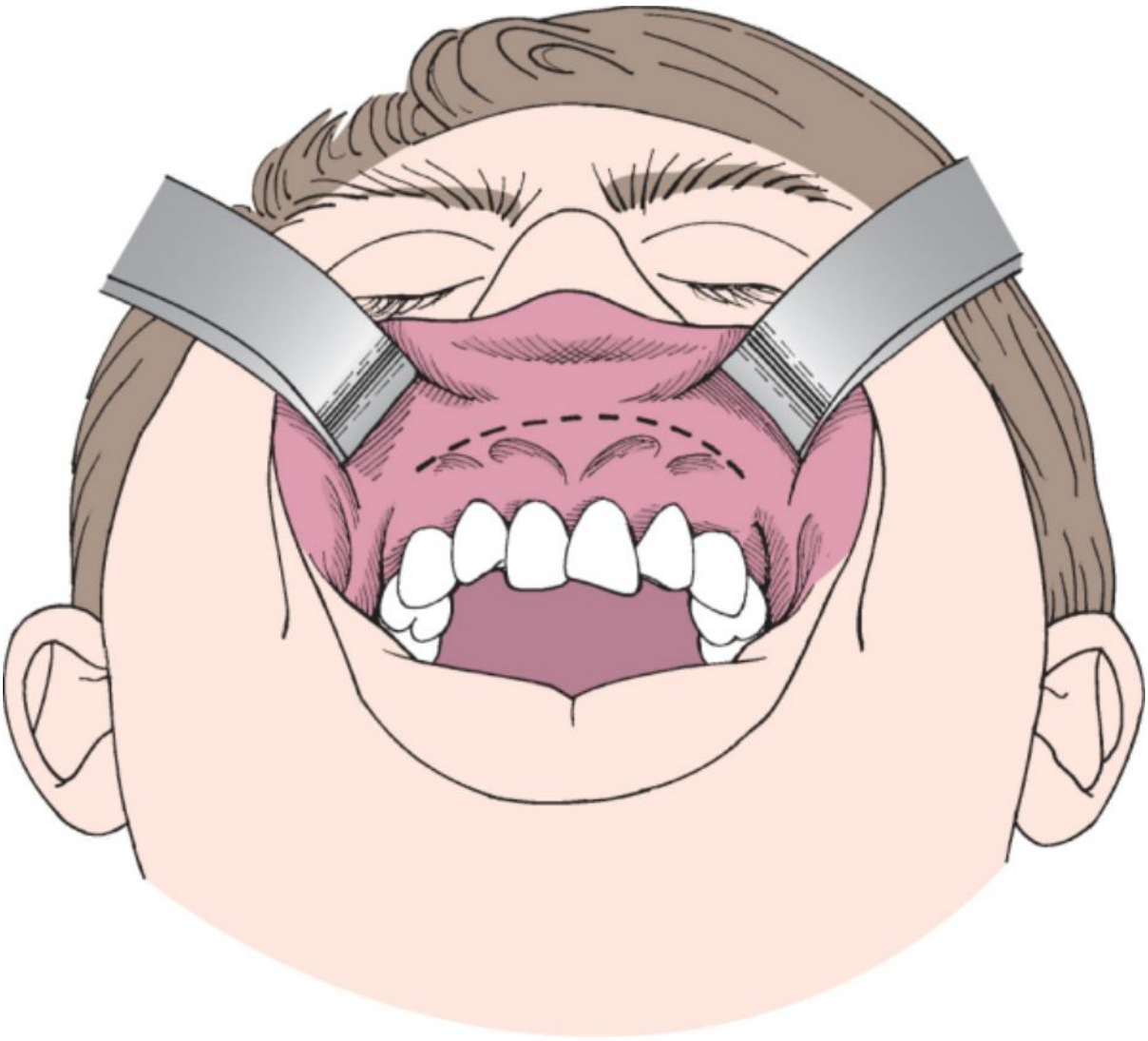

Figure 14-6 Gingivobuccal incision.
(Redrawn from Lee KJ: The sublabial transseptal transsphenoidal approach to the hypophysis. Laryngoscope 88[Suppl 10]:1-65, 1978.)

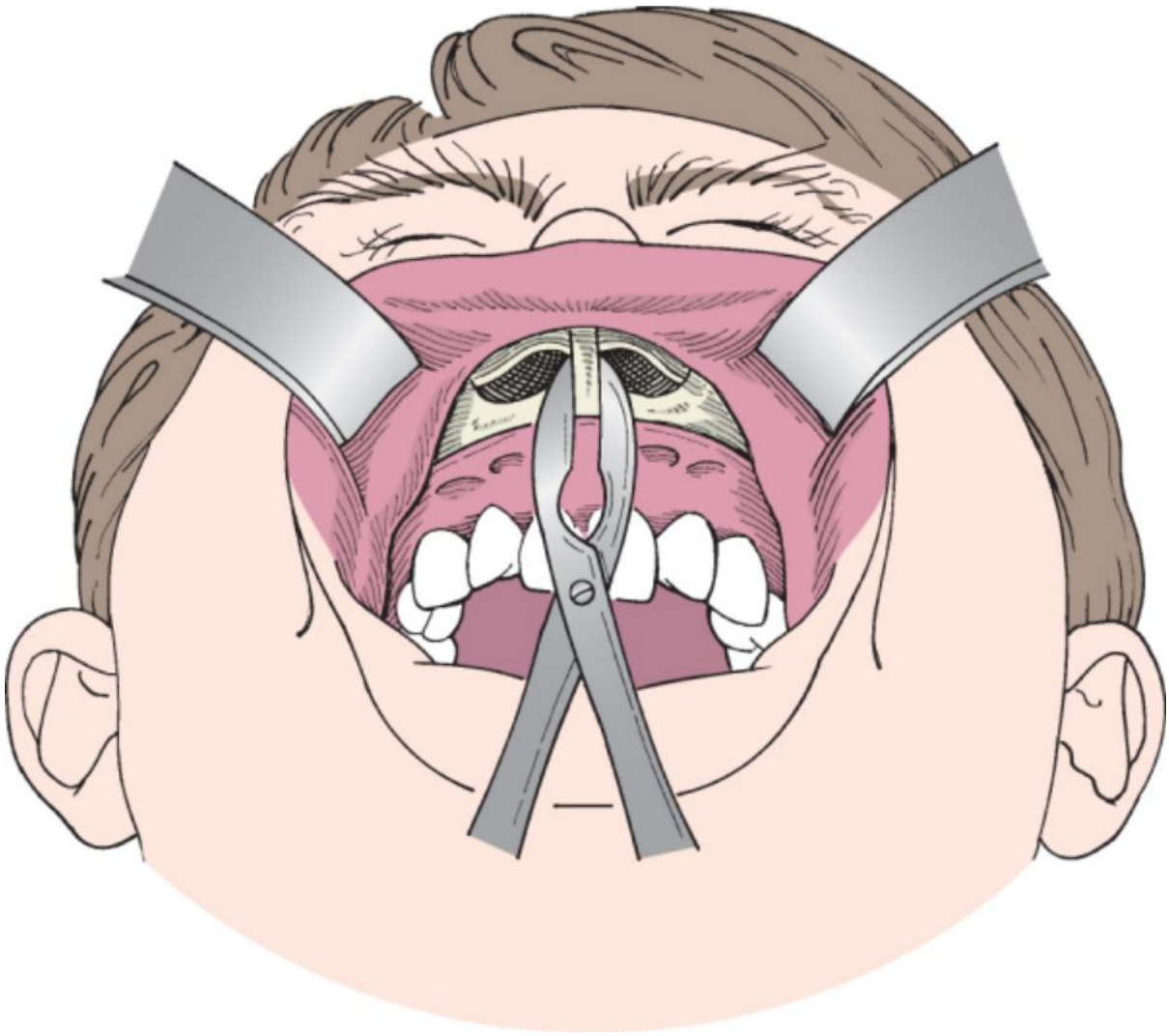

Figure 14-7 Freeing the nasal spine. Although the spine can be removed, it is easiest to leave it attached to the septum to facilitate replacement at the end of the procedure.
(Redrawn from Lee KJ: The sublabial transseptal transsphenoidal approach to the hypophysis. Laryngoscope 88 [Suppl 10]:1-65, 1978.)

Some surgeons do the entire approach via sublabial incisions without intranasal tunnels; however, if one does a great deal of septoplasty, it may expedite the procedure to perform the nasal portion first.

When the elevation has reached the posterior limit of the septum, the bone will begin to move laterally. The bone of the posterior septum is removed, withextreme care paid to its articulation with the skull base. Exposure of the anterior face of the sphenoid is facilitated by inserting a Hardy self-retaining speculum (Fig. 14-8). Care must be taken to ensure that the blades of the speculum straddle the remaining attachment of the posterior septum to the vomer without injuring the mucosal flaps. The speculum is advanced slowly and the blades are opened once the posterior limit is reached. Care must be taken to not entrap the mucosa between the end of the speculum and the sphenoid rostrum or perforation of the posterior flap can occur during bone removal. These flaps will be relied on if CSF is encountered or the sinus is obliterated. The point of entrance into the sphenoid sinus is based on the anatomy of the rostrum, with the sphenoid sinus frequently being entered through the ostium or a natural dehiscence. The bone of the front wall of the sphenoid is removed maximally with Kerrison punches for exposure (Fig. 14-9). The speculum is positioned so that blades are not allowed to enter the sinus.

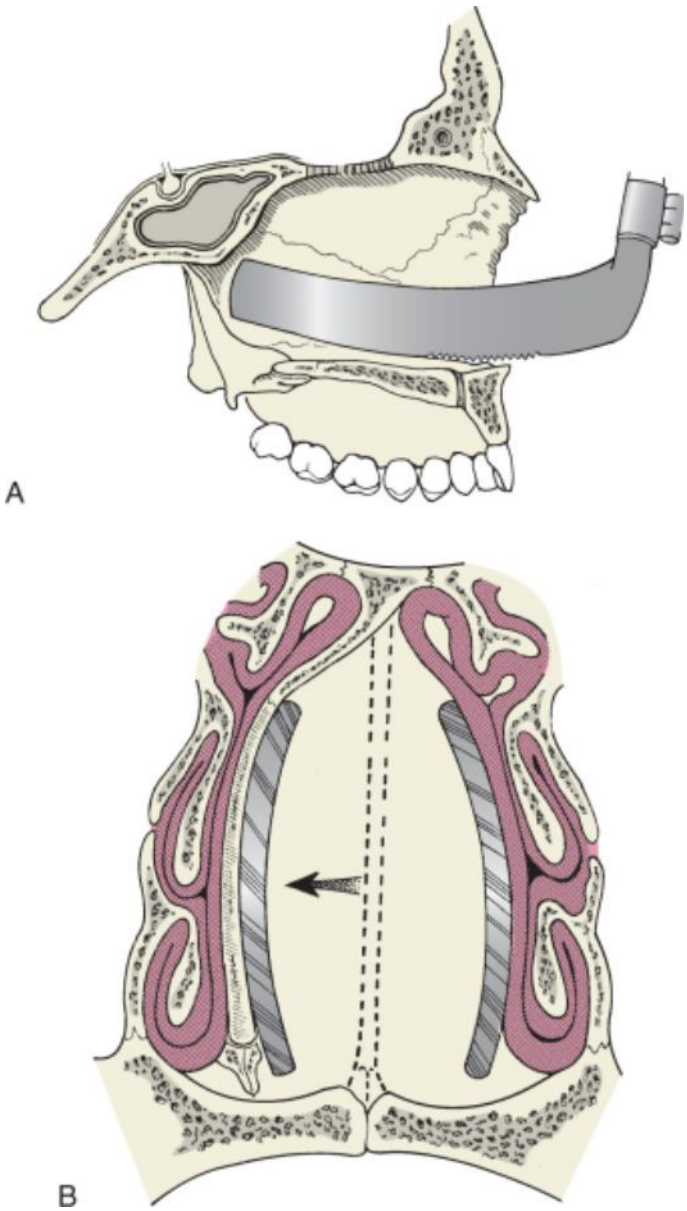

Figure 14-8 **A** and **B**, Insertion of a Hubbard or Hardy self-retaining speculum between the blades of a Killian speculum. It is important that the vomer be straddled by the speculum as it is inserted.
(A, Redrawn from Petcu MS, Sasaki CT: Pituitary tumors. In Pillsbury HC III, Goldsmith MM III [eds]: Operative Challenges in Otolaryngology—Head and Neck Surgery. Chicago, Year Book, 1990, pp 160-175.)

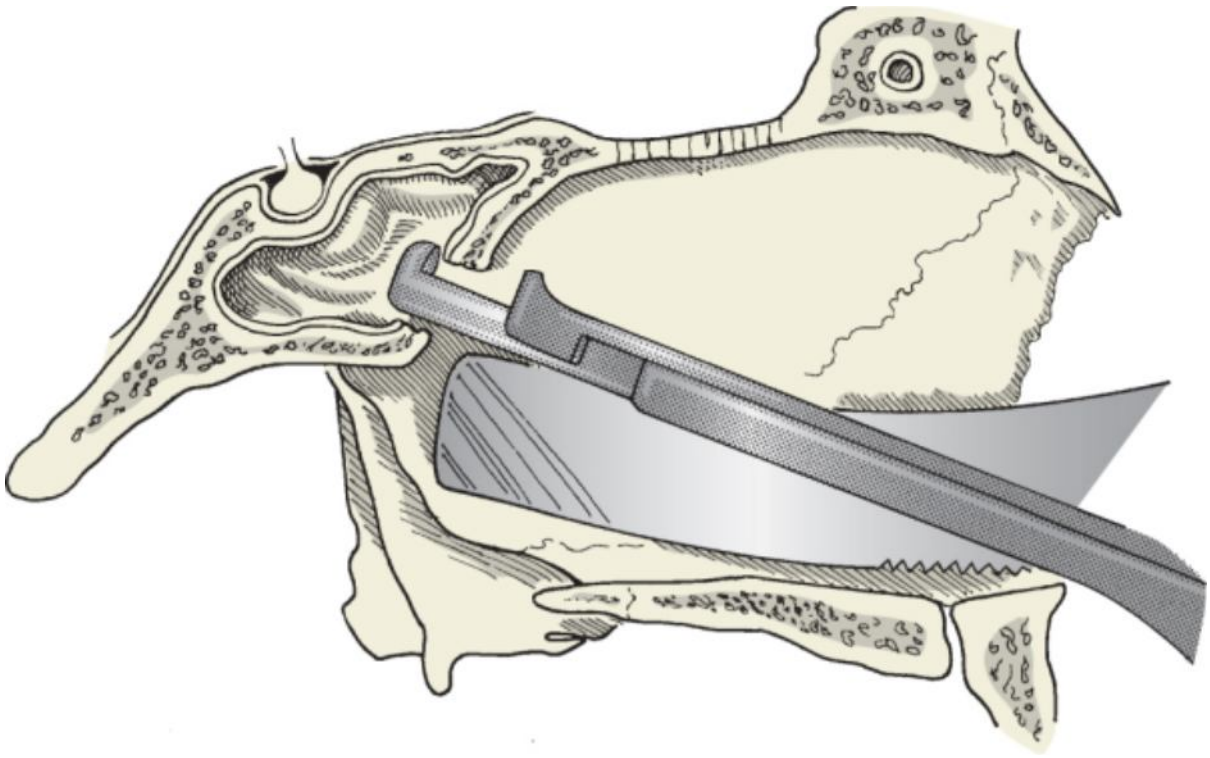

Figure 14-9 Enlarging the sphenoidotomy with a bone punch.
(Redrawn from Petcu MS, Sasaki CT: Pituitary tumors. In Pillsbury HC III, Goldsmith MM III [eds]: Operative Challenges in Otolaryngology—Head and Neck Surgery. Chicago, Year Book, 1990, pp 160-175.)

An operating microscope with a 300- or 350-mm lens is brought into position for most pituitary cases, but a nasal endoscope can also be used. The mucosa within the sinus is generally respected and preserved unless obliteration is planned. Removing it causes annoying bleeding.

After the neurosurgeon completes the pituitary procedure, the incisions can be closed. Cartilage or bone can be used to reconstruct the sella if necessary. Any CSF leakage must be managed with tissue grafts. The sphenoid is obliterated with fat only if necessary, but the mucosa must be completely stripped in this case to prevent mucocele formation. The speculum is removed and the flaps are approximated to each other with a quilting absorbable suture. The cartilaginous septum is attached to the nasal spine (if left in place by the neurosurgeons) with clear nylon. The gingivobuccal incisions are closed with 3-0 chromic suture. Splints and packing are often used, but this author does not generally use either for these cases, which greatly increases patient comfort. If an obliteration was performed, packing is placed to support the posterior septal flaps against the sphenoid tissue.

Transnasal Approach

Endoscopic approaches are performed either medial to the middle turbinate in direct fashion or lateral to the turbinate through the ethmoid.[4–6] The landmarks for both will be described.

Endoscopic surgery requires maximal decongestion of the nose to facilitate exposure and minimize bleeding, which can soil the telescope. Decongestant nasal spray is started 30 minutes before the patient comes to the operating room and continues during the preparation period. Local injections for a direct route use epinephrine-containing local anesthesia delivered through a spinal needle. Sphenoid surgery in our center is performed as a two-surgeon technique with the assistant holding the telescope and the surgeon holding an instrument and a suction device. The middle turbinate is gently lateralized to get it out of the way and to avoid any traumatic bleeding that might soil the lens. A 0-degree scope works well for the approach. The superior turbinate is located. The entry will proceed between the superior turbinate and the septum. The natural ostium can often be located in a far superior location. On occasion, removal of the inferior third of the superior turbinate facilitates location of the os.

As is the case when opening any sinus ostium, one should try to preserve mucosa 180 degrees around the ostium. For sphenoid surgery this is usually most conveniently done by opening the sinus inferior to the ostium and protecting the mucosal rim superiorly. Up- and down-biting Kerrison 1- and 3-mm forceps facilitate removal of the bone of the front face of the sphenoid sinus to deal with most pathologies. In patients in whom the ostium cannot be identified, the arch of the choana is used as a reference point. The surgeon can safely enter the sphenoid sinus between the superior turbinate and the septum 1.5 cm above the arch in a well-pneumatized sphenoid. Axial and

coronal CT scans must be reviewed before entry.

In approaching midline pathology, as in endoscopic pituitary surgery, the surgeon may choose to open the sphenoid completely from one side of the nose. In such cases the posterior septum is incised with a sickle knife, and through-cutting forceps are used to remove the posterior septum. The rostrum is removed and wide pituitary access is achieved. The surgeon should be very careful when enlarging the front wall of the sphenoid inferiorly. The choanal branch of the sphenopalatine artery is often violated, but it may or may not bleed immediately. We prefer to look for the artery and use monopolar suction cautery on the mucosa on either side of the sphenoidotomy, even in the absence of frank bleeding, to avoid a vessel in spasm opening later. No closure is required for these procedures, and no packing is used unless a CSF leak repair has been performed.

In the event of concomitant ethmoid surgery, total endoscopic ethmoidectomy is first performed. The sphenoid can then be located in two ways. Parsons described use of the “ridge” as a landmark for entry into the sphenoid. This ridge represents the attachment of the superior turbinate, and by dislocating this turbinate in an inferior and medial direction, its attachment is seen as a ridge. Safe surgical entry can be accomplished inferior and medial to the ridge.[7]

Alternatively, the posterior aspect of the basal lamella can be removed. By making a window at the position where the middle turbinate curves laterally to attach to the orbit, the superior turbinate can easily be visualized through the ethmoid sinus. At this point the procedure looks exactly like a direct entry. The inferior aspect of the superior turbinate can be removed and the natural ostium of the sphenoid can be found directly between the superior turbinate and septum. There are two advantages of going to the sphenoid through the ethmoid instead of directly: one is to avoid a bloody, relatively tighter tunnel of exposure, and the other is to avoid lateral force on the middle turbinate after ethmoidectomy with the potential to disrupt the stability of the turbinate (see Videos 14-1 and 14-2).[8]

Independent of which type of entry the surgeon uses, extreme care should be taken in extracting any sphenoid pathology. A combination of suction and irrigation facilitates the extraction of inspissated secretions and fungal elements. Soft tissue masses are gently removed with forceps. Powered instruments should be used sparingly, perhaps only on the floor of the sinus, and in our hands are not used at all. The structures of the lateral nasal wall are vital and vulnerable and should be respected at all cost, particularly when dealing with inflammatory disease; the surgeon should leave inflammatory disease in place rather than aggressively removing it when it overlies critical structures. The goal of aeration and drainage should be kept in mind and mucosa preserved as much as possible.

POSTOPERATIVE MANAGEMENT

Patients undergoing surgery on the sphenoid sinus are managed similarly for all indications. Saline irrigation is the mainstay. For the majority of pathologies, mucosa is left intact at the surgical margins and healing is prompt. Minor endoscopically guided débridement may be indicated if the mucosa has been removed for greater access or exposure. Gentle care is required when instruments are within the sinus whether intraoperatively or postoperatively.

COMPLICATIONS

Because of the possibility of dehiscence of the carotid artery and optic nerve, these structures are vulnerable on the lateral wall of the sphenoid. It is better to leave inflamed tissue on these structures than to place them at risk. Injury to the optic nerve cannot be repaired.

If the carotid is violated, the nose is promptly packed with large amounts of packing material. Blood transfusion may be necessary and the patient should be taken immediately to the angiography suite. Balloon occlusion is used to control bleeding but has a significant attendant risk of neurologic complications.

Leakage of CSF should be dealt with as per other locations. The defect must be appreciated and the mucosa stripped around it. An appropriate tissue graft is designed. An overlay technique is acceptable for smaller defects, but those larger than 1 cm should be treated with an underlay graft. Tissue glue and additional grafting can be placed below the first graft and supported with packing, which starts with absorbable agents.

CONCLUSION

Approaches to the sphenoid sinus can be transethmoidal, transnasal, or transseptal. The surgeon's experience and the location of the pathology dictate the choice of procedure for each individual patient. Endoscopic techniques will continue to further decrease the frequency of use of the transseptal approach. High-quality preoperative images must be reviewed carefully and should be displayed in the room at the time of surgery. Dissection within the

confines of the sphenoid is dangerous and should be restricted to the inferior and medial aspects when possible.

PEARLS

- The approach to the sphenoid sinus is usually selected on the basis of preoperative imaging and endoscopy.
- Careful attention to imaging allows avoidance of injury to neural and vascular structures.
- Removal of inflammatory disease should never put vital structures at risk.
- Powered instrumentation should never be used within the sphenoid sinus.
- Intraoperative control of the choanal branch of the sphenopalatine artery will avoid postoperative bleeding difficulties.

PITFALLS

- Removing the mucosa of the sphenoid sinus circumferentially about the sphenoid ostia runs the risk of ostium stenosis.
- If using computerized navigation, check the device for accuracy on a known anatomic structure before entering the sphenoid.
- Have a plan in place for the unlikely complication of carotid artery rupture.
- Many patients with headaches have incidental sphenoid pathology, and the patient should be informed that correction of the abnormality on the scan may not be the solution to the headache problem.