The Transsphenoidal Approach and Its Variants: Part I
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Learning Objectives: After participating in this CME activity, the neurosurgeon should be better be able to:
1. Explain the indications for the transsphenoidal approach.
2. Describe the preoperative and anesthetic considerations for the transsphenoidal approach.
3. Enumerate the surgical steps involved in the transseptal–transsphenoidal approach.

Indications for the Transsphenoidal Approach

The most common indication for the transsphenoidal approach is resection of pituitary adenomas. This approach is used for the resection of microadenomas as well as more centrally located pituitary macroadenomas, especially those with a large and broad base. The transsphenoidal approach is not suitable, however, for tumors that have a larger parasellar component or those that have invaded the cavernous sinus (Figure 1). The transsphenoidal approach is not considered the best approach for sellar tumors, which do not have consistency similar to that of a pituitary adenoma, especially when there is no evidence of sellar enlargement. One example of this is an intrasellar meningioma, which can be suspected when the pituitary gland is well preserved and there is a plane that separates the tumor from the normal gland (Figure 2). A few craniopharyngiomas that are strictly intrasellar can be approached using the transsphenoidal approach; most craniopharyngiomas, however, are best accessed through a cranial approach.

Preoperative Radiologic Studies

Magnetic resonance imaging is the study of choice for the evaluation of pituitary adenomas. It is used to verify the anatomic features of the sella in the parasellar region. Reviewing the coronal MRI scans as well as the axial scans is helpful in verifying the relationship of the floor of the sella to the floor of the sphenoid sinus, its relationship to the clivus, and the location of the sphenoid septum. Intraoperative MRI also may be helpful, because it can help correlate the radiologic dimensions of the tumor with the actual findings during surgery. This information helps guide the extent of tumor resection and decreases the chance of leaving residual tumor behind. Careful assessment of the relationship of the carotid arteries to the sella and the tumor cavity is of utmost importance. It also is very important to identify any unusual or anomalous displacement of the carotid arteries, because such anomalies may increase the risk of injury during tumor resection. The anatomic features of the sphenoid sinus are evaluated carefully, and the MRI findings are correlated with the surgical findings to establish the location of the septum in relationship to the floor of the sella. Determination of this relationship can help minimize damage to the pituitary gland, especially when resecting pituitary microadenomas, by making it possible to open the sellar floor exactly over the microadenoma. The sphenoid sinus may have more than one septum, and it may be composed of more than two air cells. Careful attention to such variations will help the

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surgeon discern the anatomic features of the individual patient's sphenoid sinus and will aid in localizing the sellar floor and making its exposure safer.

Anesthetic Considerations

Standard endotracheal anesthesia is used for the trans-sphenoidal approach. The endotracheal tube is positioned according to the surgeon's preferred head position. We prefer to stand on the patient's right side, with the patient in the supine position. The endotracheal tube is mobilized to the left side of the patient's mouth, which is best suited for the head position and for a right-handed surgeon. During anesthesia, normotension, normocarbia, and normovolemia are maintained. The systemic arterial pressure is monitored using an arterial line to help control any elevation of the blood pressure during surgical stimulation. This elevation may be noticed especially at the time of positioning or opening of the transsphenoidal retractor. A central venous pressure line is used only when indicated.
Positioning

We favor the Mayfield three-point head holder for positioning the head (Figure 3). If the surgeon is right-handed, the patient’s neck is partly flexed and the head is rotated toward the surgeon (toward the patient’s right side) and then tilted in the opposite direction to achieve a head position as if the patient were face to face with the surgeon. A small area of the abdomen is draped for harvesting of a fat graft. The nostril area is washed with Betadine solution. The use of lumbar drainage has been recommended to help with the resection of pituitary macroadenomas, but we stopped its use without noticing any significant compromise in our ability to achieve adequate tumor resection. We replaced it with repeated Valsalva maneuvers when needed, and we find that the use of an endoscope enables us to visualize the suprasellar region for any residual tumor without the need for lumbar drainage.

The sublabial approach had been the classic approach used for transsphenoidal resection of pituitary adenomas. However, the complications of tooth and gum numbness that were common with this approach have pushed neurosurgeons to explore other approaches that fall under variations of the transsphenoidal approach to the sella. These include the transseptal–transsphenoidal approach, the endonasal transsphenoidal approach, and the endoscopic endonasal approach. The endoscopic approach uses the same landmarks as the endonasal transsphenoidal approach, as described in Part II of this discussion, to appear in the next issue Contemporary Neurosurgery (volume 24, number 26).

Transseptal–Transsphenoidal Approach

The transseptal–transsphenoidal approach differs from the endoscopic and the endonasal approaches in its utilization of submucosal dissection along the nasal septum. It begins with a mucosal incision along the cartilaginous septum. The septum is approached through the right nostril, but the submucosal dissection is carried on the left submucosal septal plane. The mucosa is dissected very carefully on its most anterior portion, where it is most adherent. Once the submucosal plane is well

Figure 2. A, Sagittal and B, coronal gadolinium-enhanced T1-weighted MRI scans showing a suprasellar tumor with preservation of the pituitary gland. This tumor is incorporated within the pituitary stalk and is a contraindication for the transsphenoidal approach.

Figure 3. A, Front and B, top views of a patient positioned for the transsphenoidal approach.
established, the cartilaginous septum is followed posteriorly until its junction with the bony septum. The cartilaginous septum has a characteristic grayish-white glistening look that makes it easy for the operating neurosurgeon to find. It is important to dissect the mucosal plane along its superior-inferior extent to establish a wide mucosal flap, which helps avoid its being torn when the nasal and transsphenoidal speculums are applied. The submucosal dissection is carried further posteriorly and beyond the bony septum, until the left side of the anterior face of the sphenoid sinus is reached. Intraoperative fluoroscopy can be used to help direct the surgeon toward the sella. We have avoided the use of fluoroscopy in most cases, however, by relying on certain important anatomic landmarks.

The nasal speculum should be at an angle of no more than 20 degrees with the floor of the maxilla (Figure 4). The bony septum is thinnest at the level of the anterior face of the sphenoid. At that level, in most patients, the septum is thin and peels off the mucosa like eggshell. This may not be the case, however, in patients with a previous history of trauma or those with acromegaly. If the bony septum is otherwise harder and difficult to break, it suggests that the dissection plane is either too low, and the speculum is being opened against the harder spine of the maxilla, or it is too high and closer to the perpendicular plate of the ethmoid. The depth of the nostril to the anterior face of the sphenoid should always be reached using the deepest 80- to 90-mm nasal speculum. If the anterior face of the sphenoid seems to be deeper than the depth of the speculum, that suggests that the speculum is either too high in the direction of the ethmoid sinuses or anterior frontal fossa, or it is too low and along the direction of the roof of the nasopharynx (Figure 5).

Although anatomic variations may be seen in these landmarks, by using the landmarks and our knowledge of the anatomy of the nasal anatomy as a guide, we have been able to avoid the use of intraoperative fluoroscopy in our last 250 transsphenoidal operations. However, when in doubt, we recognize the value of intraoperative fluoroscopy.

When the anterior face of the sphenoid sinus is reached, the nasal speculum is opened and mobilized from the left submucosal plane across the septal plane to the right. This maneuver fractures the thinnest part of the bony septum and puts its most posterior portion in the middle of the surgical field. Further dissection of the submucosal plane on both sides of the septum is done both superiorly and inferiorly using the transsphenoidal suction device. The self-retaining retractor is then put in place. While the surgeon is performing this step, the anesthesiologist is warned to watch the patient’s blood pressure, because in some patients the stimulation caused by stretching the mucosa and the posterior portion of the nasal cavity can cause a significant elevation in the systemic blood pressure. The exposed anterior face of the sphenoid with the protruding portion of the septum has a characteristic look resembling the keel of a boat (Figure 6).

**Bone Removal**

The sphenoid ostia are then localized and used to start the bony removal of the anterior face of the sphenoid using Kerrison rongeurs. Whether to remove the mucosa of the sphenoid sinus completely or partially is an ongoing controversy. We routinely remove it completely to avoid the possible occurrence of a sphenoid sinus mucocele. At this stage, we correlate the features of the sphenoid sinus seen...
on MRI with the surgical view. Both the sellar dimensions and features are studied. The shape of the sphenoid sinus also is observed and correlated with the anatomic landmarks of the sella and its relationship to the clivus. The lateral walls of the anterior face of the sphenoid sinus are removed to help visualize the lateral extension of the sella and the prominences of the internal carotid arteries. This step helps the neurosurgeon to establish a three-dimensional image of the tumor in his or her mind, and it helps guide the extent of tumor resection and the choice of instruments to be used during the resection.

Exposure of the Sella

When the sella is enlarged, its floor usually is thin enough to be cracked by pushing against it with a forceps or a dis-sector. Kerrison rongeurs are used to remove the rest of the floor of the sella. In some cases, a chisel is needed to crack a harder sellar floor.

In a well-aerated sphenoid sinus, the sella usually is well visualized (see Figure 6). However, variations in the shape of the sphenoid sinus can make identification of the floor of the sella more difficult, especially when the sphenoid is prefixed or conchal (Figure 7). When a prefixed sphenoid is encountered, an assessment of the distance from the roof of the sphenoid sinus (which also is where the floor of the frontal fossa is located) to the expected location of the floor of the sella is measured on the MRI scan. If its position is still in doubt, an intraoperative lateral skull x-ray can be used for localization. A conchal sphenoid can be more challenging. Even though the location of the floor of the sella can be established easily on a lateral skull x-ray, the difficulty with a conchal sphenoid is staying on midline to avoid injury to the internal carotid arteries. This becomes especially significant when it is necessary to drill the thick bone of a conchal sphenoid sinus. A conchal sphenoid has been considered an indication for use of a cranial approach. More recently, however, the introduction of intraoperative navigational techniques has helped avoid the need for a craniotomy in such cases (Figure 8). The use of neuronavigational systems recently has become more popular, especially for guidance.
during the transsphenoidal approach. However, neurosurgeons should not rely on this technology without also knowing how to establish the approach using strictly anatomic landmarks, because that knowledge provides a safety net in the event the neuronavigational system fails.

Once the dura is exposed, a no. 11 blade is used to open it. The knife is used gently, barely scratching the dura open. This light touch is used as a precaution, to avoid deep insertion of the blade into the sella. (If the blade enters deeply into the sella, there is potential for injury to the internal carotid artery, which could be displaced medially and anteriorly in the sella and into the surgical field.) The tumor resection is then performed. The resection procedure will be addressed in detail in Part II of this article, to appear in the next issue of Contemporary Neurosurgery (volume 24, number 26).

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1. The transsphenoidal approach is indicated for suprasellar lesions even when the lesion is above the sella and the sella is not enlarged.

   **True or False?**

2. The anatomy of the sphenoid sinus is very consistent, with one septum and two air cells.

   **True or False?**

3. The bony septum is thickest at the level of the anterior face of the sphenoid.

   **True or False?**

4. A conchal sphenoid is a sphenoid sinus that is predominantly bony with no air cells.

   **True or False?**

5. One of the main ways in which the transseptal–transsphenoidal approach differs from the endonasal approach is the former’s more extensive submucosal dissection along the nasal septum.

   **True or False?**

6. If the anterior face of the sphenoid cannot be reached with an 80- to 90-mm nasal speculum, this suggests that the dissection is either too high in the direction of the ethmoid or too low in the direction of the nasopharynx.

   **True or False?**

7. Nowadays the transsphenoidal approach can be done using neuronavigational systems, without the need for understanding the anatomy of the nasal cavity.

   **True or False?**

8. The exposed anterior face of the sphenoid resembles the keel of a boat.

   **True or False?**

9. The sella is easy to recognize in a prefixed sphenoid sinus.

   **True or False?**

10. A conchal sphenoid sinus is a strong indication for the use of intraoperative navigation system.

    **True or False?**