Sphenoid sinus disease is recognized as an unusual clinical entity. It is likely that sphenoid sinus disease is underreported because of its lack of recognition. Sphenoid sinus disease often has an insidious onset with nonspecific symptoms. Furthermore, optimal physical exam is difficult due to the relative inaccessibility of the sinus. O.E. Van Alyea stated, “Every year or two the sphenoid sinus is taken out of obscurity, given an airing, then returned to its role as the most neglected of the nasal sinuses.”

Anatomy

The sphenoid sinuses originate during the fourth fetal month as evaginations in the sphenoeethmoidal recess. They remain as small indentations until the age of three when further pneumatization occurs. Adult size is not reached until about 18 years of age with volumes of approximately 7.5 mL. Congdon classified three types of pneumatizations in respect to the sella. The first type, described as conchal (5%), exists when the posterior extent of the sphenoid sinus is well anterior to the sella turcica. The presellar type (23%) occurs when the posterior wall of the sphenoid sinus reaches the anterior face of the sella turcica. The sellar or postsellar type (67%) occurs when the sphenoid sinus extends past the level of the sella turcica to approach the pons posteriorly, allowing the sella to make a superior indentation in the sinus.

The sphenoid sinus is a paired structure that is located predominantly in the sphenoid bone. The two sinus cavities are separated by a complete bony septum, approximately 0.6 mm thick, located in the midsagittal plane. Some asymmetry in size and shape is nearly always present, but marked septal deviations are relatively rare.

The walls of the sphenoid sinus are irregular. Bony septae partially separate recesses, producing incomplete compartmentalization of the sinus. There may be dehiscences in the bony sinus wall, especially laterally and superiorly, where it is only about 1 mm thick. Such dehiscences may result in direct contacts between the sinus mucosa and the overlying dura.

The sphenoid sinus is located in a central position in the skull. It is surrounded by several important anatomic structures. Superior to the sinus are the cerebral hypophysis, olfactory tract, frontal lobes of the brain, and an often extensive intercavernous venous
network. Anterosuperiorly, the optic chiasm is present. Anteriorly, the anterior margin of the sphenoid bone forms a small segment of the posterior orbital wall.

Inferiorly, the nasopharynx is present, as are the blood vessels and the nerve of the pterygoid canal, which run anteroposteriorly immediately below the sinus floor. These structures may be surrounded completely by the bony wall of the pterygoid canal, or they may lie directly underneath the mucosa of the sinus floor.

Posteriorly, a thick, bony wall separates the sinus from the basilar artery and the pons. Anteriorly, an incomplete bony wall separates the sinus mucosa from the nasal mucosa and from the posterior ethmoid sinuses. If the sphenoid sinus is larger, it may extend over the pterygopalatine fossa with its contents, and it may be located directly posterior to the maxillary sinus.

Laterally, a thin, bony wall with occasional dehiscences separates the sphenoid sinus from Meckels’s cave, the cavernous sinus, the internal carotid artery (which may leave a depression in the bony wall or even be in direct contact with the sinus mucosa), and, along the lower border of the sinus, the maxillary division of the trigeminal nerve.

The ostium of the sphenoid sinus is located high on the anterior sinus wall approximately 1/3 to ½ up the face of the sinus. The sinus drains into the posterior most portion of the sphenoid ethmoid recess, above the level of the superior turbinate.

Van Alyea performed a comprehensive study on cadaver heads and found that the carotid artery caused elevations on the lateral wall in 65% of sphenoid sinuses. The optic, vidian, and maxillary nerves were noted in 47%, 48%, and 42% of the sinuses, respectively. He did not note any dehiscences in these sinuses but other authors have reported this.

Background

As stated, sphenoid sinus disease is difficult to diagnose due to a lack of specific symptoms. Headache is the most common symptom and may be present in both inflammatory and expansile lesions of the sphenoid sinus. The incidence of headache ranges from 33% to 81% and is typically retroorbital. Space-occupying lesions such as tumors and mucoceles are more likely to present with visual changes than with inflammatory disease. Visual symptoms include diplopia, blurring, isolated oculomotor palsies, and transient loss of vision. Involvement of the cavernous sinus may also result in palsies of the third, fourth, and sixth cranial nerves as well as paresthesias from the fifth cranial nerve. The sixth cranial nerve is the most frequently affected cranial nerve in sphenoid sinus tumors.

The most common disease of the sphenoid sinus is sinusitis. Symptoms include dull-aching headache, nasal discharge, and occasionally visual symptoms. Early diagnosis and aggressive treatment are the most important factors in reducing morbidity. The acute phase is managed with antibiotics and decongestants. If possible, the sinus can be cannulated and irrigated. The most common surgical management would be endoscopic sphenoidotomy.

A mucocele is the most common space-occupying lesion in the sphenoid sinus. Patients with mucoceles may present with headaches, visual disturbances, anosmia, or even endocrine abnormalities. Radiographs are usually diagnostic. Treatment is sinusotomy with either drainage or removal of the mucocele.
Polyps can occur as isolated sphenoid lesions but are more commonly associated with polyps of the posterior ethmoid air cells. The patient usually has long-standing rhinosinusitis, postnasal discharge, and headache. Radiologic evaluation will show sinus opacification and mucosal thickening.

Inverting papillomas usually result from extension of antral and ethmoidal tumors but primary tumors of the sphenoid have been reported. Treatment should be aggressive as they tend to recur and can undergo malignant transformation. Excision with a wide margin of normal tissue is recommended. High recurrence rates in the sphenoid sinus is typical since margins are difficult to obtain due to the adjacent vital structures.

Malignant lesions rarely occur but include squamous cell carcinomas, adenocarcinomas, lymphoepitheliomas, melanomas, and various sarcomas. Complete excision is usually impossible but sphenoidotomy for biopsy and decompression is usually required in the initial stages of treatment.

Benign tumors of the pituitary constitute the majority of sellar lesions requiring transsphenoidal surgery. These tumors are often described as being encapsulated and are often demarcated from the normal pituitary on radiologic exam. Classically, the tumors were described as basophilic, acidophilic, or chromophobic depending on how they stained during pathologic study. With newer immunostaining techniques, the specific cell origin can be determined in approximately 75% of cases. They now can be classified as containing prolactin, growth hormone, adrenocorticotropic hormone (ACTH), follicle stimulating hormone (FSH), or thyroid stimulating hormone (TSH). Prolactinomas represent 40% to 50% of all adenomas. Somatotropin adenomas causing acromegaly account for 15% to 25% of adenomas. Corticotropin secreting tumors, causing Cushing’s disease or Nelson’s syndrome, represent 5% of tumors. The rarest type of pituitary adenomas include thyrotropin or gonadotropin secreting tumors and account for less than one percent of tumors. In addition, 10% to 15% of tumors are found to secrete multiple hormones.

Craniopharyngiomas are one of the most common intracranial tumors of childhood but can be seen in older patients. They may be cystic or solid and many show calcifications on radiography. These are slow growing tumors that cause symptoms by compressing adjacent structures including the pituitary, optic chiasm, and other basal brain structures. Total extirpation is the goal as subtotally resected tumors tend to recur.

Other sellar lesions include the occasional dermoid and epidermoid cysts, germ cell tumors, chordomas, and both benign and malignant osseous lesions. Also, nearly ten percent of meningiomas occur in the region of the sella.

**Evaluation**

As with any other problem the otolaryngologist faces, the evaluation begins with thorough history and physical. Special attention should be paid to the neurologic exam evaluating vision and sensation of the face. After anterior rhinoscopy, the nose should be decongested and anesthetized with topical solutions and endoscopic exam is performed. Septal deviations, hypertrophy of the turbinates, signs of infection or inflammation, and loss of natural landmarks from prior surgery should all be noted. Radiologic testing should then be performed with computed tomography (CT) being the study of choice for most rhinologists. Magnetic resonance imaging (MRI) is often obtained by neurosurgical
colleagues if sellar tumors are being evaluated. If there is marked enhancement of a tumor, an angiogram is necessary to rule out vascular lesions. Often, endocrine consultation is obtained when investigating pituitary tumors.

Approaches

Surgical approaches to the sphenoid sinus began in the early 20th century as recognition of sellar tumors became known with advances in neurology, pathology, and radiology. Krause credits himself with the first transfrontal approach to the pituitary in 1905 and described much difficulty with gaining access to the sella due to the incompressibility of the frontal lobes. Schloffer performed the first transnasal route in 1907. Via a lateral rhinotomy incision, he removed the septum, turbinates, and ethmoids to access the sella, with only the sun as lighting. The next several years led to many advances in the transnasal approach with contributions by von Eiselberg, Stumme, Kanaval, Halstead, and Kocher. In 1910, Cushing performed essentially the present-day sublabial transseptal operation with success. In the 1920’s there was a shift back to extracranial routes to the pituitary when antibiotics were introduced. In the 1960’s, Hardy reintroduced Cushing’s approach which is now the most common route to the sella.

Of all the techniques designed to reach the sphenoid sinus and sella turcica the most popular is the transseptal approach. The transethmoidal and transantral procedures have their proponents, however. The transseptal operation is useful because it is easy, rapid, and cosmetically pleasing. For the experienced surgeon, all of the possible approaches to the sella are safe. For surgeons who do not perform sphenoid sinus procedures often, the transseptal approach is safest because it is a midline approach in an area anatomically familiar to most otolaryngologists.

Transsphenoidal hypophysectomy

Transseptal approaches

Sublabial transseptal

Initially, a lumbar drain is placed in case air must be injected into the subarachnoid space to outline the suprasellar region. The operation is begun by a transfixion incision along the left nasal septum. A mucoperichondrial tunnel is elevated along the left septum from anterior to posterior over the quadrangular cartilage, perpendicular plate of the ethmoid, and vomer. Inferior tunnels are then elevated bilaterally in a submucoperiosteal plane lateral to the nasal spine. The mucosa is left intact and not elevated along the right side of the quadrangular cartilage. A vertical incision is then made in the posterior quadrangular cartilage near the perpendicular plate of the ethmoid. The mucoperiosteum along the right nasal septum is then elevated posteriorly over the perpendicular plate and vomer. The cartilaginous septum is then separated from the nasal spine and maxillary crest and translocated to the right. The bony septum is taken down to the sphenoid rostrum. A sublabial incision is made between the canine fossae bilaterally and the sublabial and transnasal exposures are connected. The hypophysectomy speculum is then inserted through the sublabial incision between the
mucosal flaps to sphenoid rostrum. The anterior wall of the sphenoid and intersinus septum is removed and the neurosurgeon begins the hypophysectomy. After completion the cartilaginous septum must be secured into the prespine fossa with suture. The septal and sublabial incisions are closed accordingly. A quilting stitch is used to secure the mucosal flaps and nasal packing is placed for 3 to 5 days.

**Endoscopic transseptal**
This technique using the rigid nasal endoscopes is begun by lateralizing the middle turbinate, exposing the sphenooethmoidal recess, and natural ostia of the sphenoid sinuses. A semilunar incision is made posteriorly on the vomer and mucoperiosteal flaps are elevated bilaterally. The vomer is resected saving the inferior portion as a landmark for midline. The anterior wall of the sphenoid sinus is removed starting at the natural ostia. The intersinus septum is removed and the Hardy speculum is placed deep between the mucoperiosteal flaps as far down as the open sinus. From this point on the operation proceeds as normal with the operating microscope.

**External rhinoplasty**
Popularized by Parnes and Koltau among others, the external rhinoplasty technique has the advantages of enhanced exposure while limiting the problems with sublabial dissection (gingival numbness, denture problems, contamination of the field with oral flora). A standard external rhinoplasty incision employing the inverted V is made and columellar flaps are raised to the midportion of the lower lateral cartilages. Complete exposure of the lateral crura and the upper lateral cartilages is unnecessary. The caudal edge of the quadrilateral cartilage is exposed by dividing the intercrural ligaments between the medial crura. A mucoperichondrial flap on one side of the quadrilateral cartilage is developed and continued over the perpendicular plate of the ethmoid and vomer. Dissection proceeds onto the maxillary crest and the floor of the nose, connecting the medial and inferior tunnels. The quadrilateral cartilage is detached posteriorly at the bony cartilaginous junction and the mucoperiosteum on the opposite side of the ethmoid and vomer is elevated. The cartilage is then disarticulated from the maxillary crest. The mucoperiosteal elevation is continued on the maxillary crest and the floor of the nose on the opposite side. The Hardy speculum is inserted, displacing the septal leaflets laterally. The perpendicular plate of the ethmoid is resected, taking care to preserve the vomer, which serves as a midline guide to the anterior face of the sphenoid. The anterior sinus wall is opened, the intersinus septum is removed, and the sinus mucosa is exenterated.

An additional procedure has been described by Peters and Zitsch using a modification of the columellar flap. A complete transfixion incision is made at the caudal septum and an incision is made at the base of the columella. The quadrangular cartilage is accessed via this incision and it requires no separation of the medial crura. The operation then proceeds in the previous manner.

**Endoscopic transseptal**
A variety of septal incisions can be made and combined with a lateral alotomy for quick and direct access to the sphenoid. Once the incisions are made, elevation and dissection proceeds as with the other transseptal procedures.
Previous septal surgery

Prior septal surgery usually results in areas of missing bone or cartilage where septal mucosa on one side is directly adherent to mucosa on the opposite side, with little intervening tissue. If transseptal approaches are necessary, there are several methods possible to avoid septal perforations. First, septoplasty with avoidance of the problem area can be done if the area of missing bone or cartilage is small. When the problem area is superior, the usual sublabial approach can be used. If there is an inferiorly placed problem area, the external rhinoplasty approach can be used. Secondly, septoplasty with dissection through adherent mucosal areas can be done. The time since previous surgery, thickness of the tissue, and skill of the surgeon all influence the practicality of this option. Lastly, the septum can be laterally displaced, thus going around the problem area. With this approach, an incision paralleling the septum is made laterally in the mucosa of the floor of the nose, near the inferior turbinate. A complete transfixion incision is made, extending laterally around the pyriform margin and connecting with the first incision in the floor of the nose. The mucoperiosteum along the floor of the nose is elevated with a Freer elevator to the septum. The anterior septum is dissected free of any remaining maxillary crest and nasal spine. Dissection progresses posteriorly until residual solid bone is encountered. Once the anterior septum is free of the maxillary crest, the mucosa on the other nasal floor is elevated. A self-retaining retractor is placed just short of the remaining posterior bony septum and the septum with attached floor mucosa is retracted laterally. An incision is made on the existing bony septum and the operation proceeds as normal.

Transantral approaches

This approach is begun through a Caldwell-Luc approach. The medial wall of the antrum is taken down and anterior and posterior ethmoidectomies are performed. After completion, the anterior wall of the sphenoid sinus is reached and removed. The intersinus septum is next taken down and removal of the tumor is begun. The disadvantage of this approach is the oblique angle taken toward the sphenoid which doesn’t allow for easy orientation with midline structures. Because of the potential complications due to this, the transantral approach is seldom used.

Transethmoidal approaches

First described by Chiari in 1912, this approach has many modifications. The usual Lynch-type incision for external ethmoidectomy is made and subperiosteal elevation proceeds posteriorly. The anterior ethmoid artery is exposed and ligated. The lamina papyracea is penetrated and enlarged. Under direct vision the anterior and posterior ethmoid cells are removed up to the anterior wall of the sphenoid sinus. Using an operating microscope the anterior wall of the sphenoid sinus in entered and the intersinus septum is removed. Advantages of the transethmoidal route include it being one third shorter than the transseptal route, lack of oral communication, and avoidance of nasal complications (septal perforation, etc.). The main disadvantage of the transethmoidal route is that the midline is not followed and loss of orientation could be
disastrous if the lateral wall of the sphenoid sinus is mistaken for the intersinus septum. Other disadvantages include the external scar and inaccessibility of the suprasellar region.  

**Sphenoid Inflammatory disease**

**Endoscopic sphenoid approaches**

Stankiewicz describes medializing the middle turbinate and then removing the anterior and posterior ends of the middle turbinate with endoscopic scissors. The posterior ethmoid sinuses are entered through the grand lamella which will then expose the anterior wall of the sphenoid sinus. After measuring and insuring correct identification of the sphenoid sinus, it is entered medially adjacent to the septum approximately 1/3 of the way up the anterior wall, at 30 degrees from the nasal spine. The sinus can then be opened inferiorly, medially, and laterally. Care should be taken opening the sinus superiorly, because a CSF leak can result if the thin roof of the sinus is entered.  

**Intranasal sphenoethmoidectomy**

After anesthesia, the middle turbinate is fractured medially and the ethmoid air cells are taken down working posteriorly. The middle turbinate is the medial border and the lamina papyracea is the lateral border of the dissection. Once the posterior attachment of the middle turbinate is reached, the turbinate is pushed laterally and the sphenoid ostium is identified posterior and slightly superior to the posterior attachment of the middle turbinate. The ostium is enlarged medially before removing the posterior attachment of the middle turbinate and the posterior ethmoid cells creating a common cavity.

**Transantral sphenoethmoidectomy**

The maxillary sinus is entered via a Caldwell-Luc type approach and the anterior wall of the sinus is taken down widely. The medial wall of the antrum is removed exposing the middle turbinate and ethmoid sinuses. The anterior face of the sphenoid sinus is identified and the ostium is enlarged. If ethmoidal disease is present, the ethmoid cells are taken down in the previously described fashion. The advantage of this procedure exists when extensive antral disease coexists with sphenoethmoidal disease.

**Sphenoid Tumors**

**Transpalatal approaches**

After proper retraction of the endotracheal tube and tongue with a mouth gag a variety of incisions can be employed in transpalatal approaches. A midline palatal split through the medial raphe is the quickest and easiest procedure to perform and allows good exposure. Once the hard palate is reached, it is removed as necessary for exposure along with the posterior vomer. This allows direct access to the rostrum of the sphenoid and nasopharynx. Closure is performed in two layers. Shortening of the palate and velopharyngeal insufficiency can result with the midline approach. U and S shaped flaps
can be used with a lesser incidence of palatal contracture and fistulae but closure is more difficult.

**Infratemporal fossa approach**

This approach may be necessary for extensive sphenoid sinus neoplasms that have invaded the cavernous sinus, pterygomaxillary space, infratemporal fossa, and nasopharynx. This is actually a combined middle cranial fossa-infratemporal fossa approach. If skull base extension has not occurred then the craniotomy portion of the procedure can be avoided.

The skin incision extends from the vertex of the scalp into the neck and flaps are elevated from the angle of the mandible to the lateral orbital rim to the calvarial vertex. The temporalis muscle is then elevated into the infratemporal fossa to where it inserts on the coronoid process. Zygomatic osteotomies are made on the zygomatic arch, lateral orbital wall, and malar eminence. The soft tissues are then completely dissected from the medial end of the glenoid fossa, to the foramen spinosum, foramen ovale, and base of the lateral pterygoid plate. The craniotomy is made and elevated along the dura. The craniotomy usually fractures across the eustachian tube which is the key maneuver in finding the internal carotid artery. The carotid is further defined with the a cutting burr. V3 is next identified as it crosses the carotid. Dissection will then lead to the cavernous sinus and parasellar region. Tumor dissection then proceeds.

**Anterior approach**

The anterior approach is performed through a lateral rhinotomy or Weber-Fergusson incision. An osteotome is used to perform a lateral osteotomy of the nose and the lateral nasal skeleton is out-fractured. The anterior and medial maxillary walls are excised and the ethmoids are exenterated. As tumor is encountered, it is removed piecemeal for added exposure. Wide margins will later be taken once exposure is adequate. The anterior wall of the sphenoid sinus is taken down and the mucosa is eradicated. The walls are then examined for evidence of tumor erosion. The walls of the sinus are managed with a burr. The floor can be removed without consequence. The roof and superior aspect of the posterior wall may require removal of the pituitary and sellar contents for extirpation. Invasion of the lateral wall presents the biggest challenge as the optic nerve and carotid are at risk.

**Complications**

Complications are related both to the nasal and neurologic portions of the procedures.

**Neurovascular complications**

The carotid artery may be traumatized and undergo severe postoperative spasm, or it may be lacerated at the time of surgery. Venous hemorrhage may occur from the cavernous sinus. If the head is significantly elevated when the sinus is opened, air embolism may occur. The nerves that run through the cavernous sinus, including the
third, fourth, fifth, and sixth cranial nerves, have all been reported to develop palsies following sphenoidal surgery. Intracranial complications include trauma to the optic chiasm. The optic chiasm can later prolapse into the decompressed sella. There are also cases of chiasmal compression by fat or muscle that has been packed into the sinus. Cerebrospinal fluid leaks are not uncommon during hypophysectomy and can lead to meningitis.  

Rhinologic complications

The incidence of rhinologic complications has been reported to be as high as 50% by some authors but is minimized if careful dissection is performed. Complications include septal perforation, epistaxis, synchiae, anosmia, and cosmetic deformity. Reportedly 10% of columellar incisions are visible but again careful technique can minimize this when using the external rhinoplasty approach. With the sublabial approach, the nasal spine is often resected so that visualization is not compromised. Loss of the nasal spine can lead to a loss of nasal tip projection and a decrease in the nasolabial angle. It is recommended that the anterior nasal spine not be removed if visualization is adequate. Resection of the cartilaginous septum without careful attention to the dorsal and caudal struts can lead to saddle-nose deformities.

Bibliography


