– ETHMOID SINUS

Chapter 12 – The Endoscopic Approach

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The indications for endoscopic ethmoidectomy should be tailored to the individual patient and the extent of chronic rhinosinusitis. The goal is to restore function to the ethmoid cells and frequently to restore function to the frontal and maxillary sinuses, which can be secondarily infected or diseased because of obstruction from disease in the anterior ethmoid cavity. Patients with limited disease are candidates for endoscopic sinus surgery (ESS) targeted at the anatomic obstruction. This may allow return of function to the ethmoid cavity and the dependent sinuses. An anterior ethmoidectomy is frequently performed in concert with functional surgery involving the ethmoid infundibulum, which is enlarged by removing the uncinate and obstructing or diseased agger nasi and infundibular cells.

Not all ESS is functional. Patients with hyperplastic sinus disease or disorders such as cystic fibrosis or ciliary dyskinesia, do not have functional sinuses and never will. The goal in these patients is to marsupialize the ethmoid sinuses in continuity with other involved sinuses to the greatest extent possible to optimize the application of topical anti-inflammatory agents, topical antibiotics, and topical irrigations and débridements.

ANATOMY

An appreciation of the anatomy of the ethmoid sinuses and its relationship to surrounding sinuses, orbit, and skull base is critical to performing safe ESS. The anatomy is complex because of the wide variety of pneumatization patterns. Certain landmarks are constant and should be sought in each patient to ensure safe surgery. An appreciation of sinus anatomy is facilitated by preoperative study of the coronal unenhanced sinus computed tomography (CT) scan and study of reconstructed sagittal and axial views. Reconstructed images from a multislice helical scanner performed in the axial plane at 1-mm intervals with a 50% overlap allow for high-quality coronal and parasagittal reconstruction. Of all the sinuses, the ethmoids are most amenable to removal of all obstructive bony partitions and wide marsupialization in the case of hyperplastic disease. The dangers of ethmoid sinus surgery lie in its proximity to the orbit and skull base. Frequently, there is posterior/superior pneumatization of a posterior ethmoid cell over the sphenoid (an Onodi cell), bringing this ethmoid cell close to the optic nerve and cavernous sinus/carotid. This occurs in up to 60% of Southeast Asian cadavers, but is significantly less in other populations.[1]

The ethmoid sinuses comprise a honeycomb-like complex of individual cells and are divided into the anterior and posterior ethmoid cells. The cell complex varies and ranges from one or two cells to more than 15. The distinction between anterior and posterior ethmoid cells is based on drainage pathways, with the anterior cells emptying into the middle meatus and the posterior cells draining into the superior meatus above the middle turbinate. The ground or basal lamella of the middle turbinate separates the anterior and posterior ethmoid cells. Identification of the ground lamella is thus one landmark in entering the posterior ethmoid complex (Figs. 12-1 and 12-2).

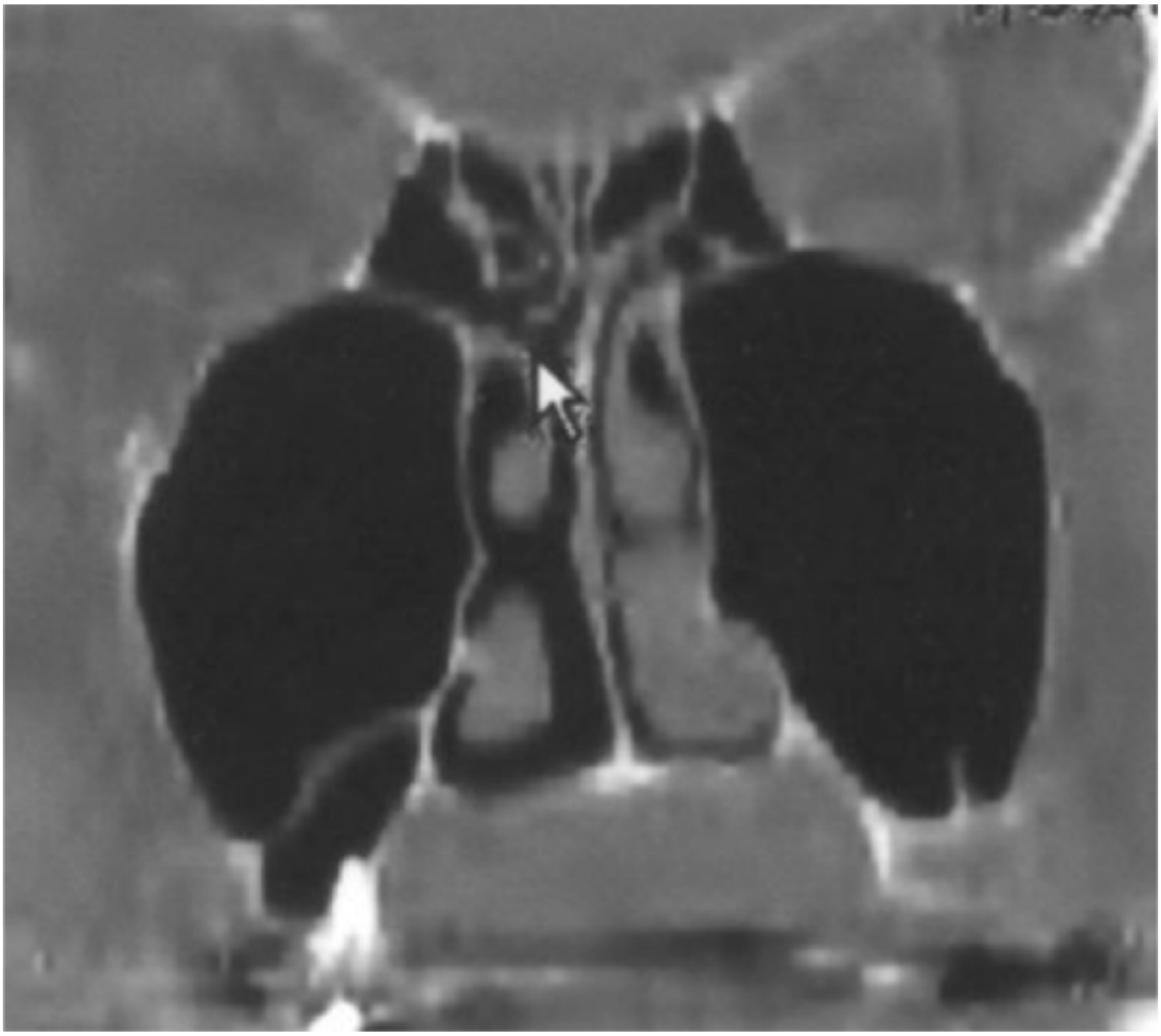

Figure 12-1 In this coronal computed tomography scan, the arrow identifies the opening of the posterior ethmoid cells above the middle turbinate in the superior meatus. The arrow is also adjacent to the basal lamina of the middle turbinate.

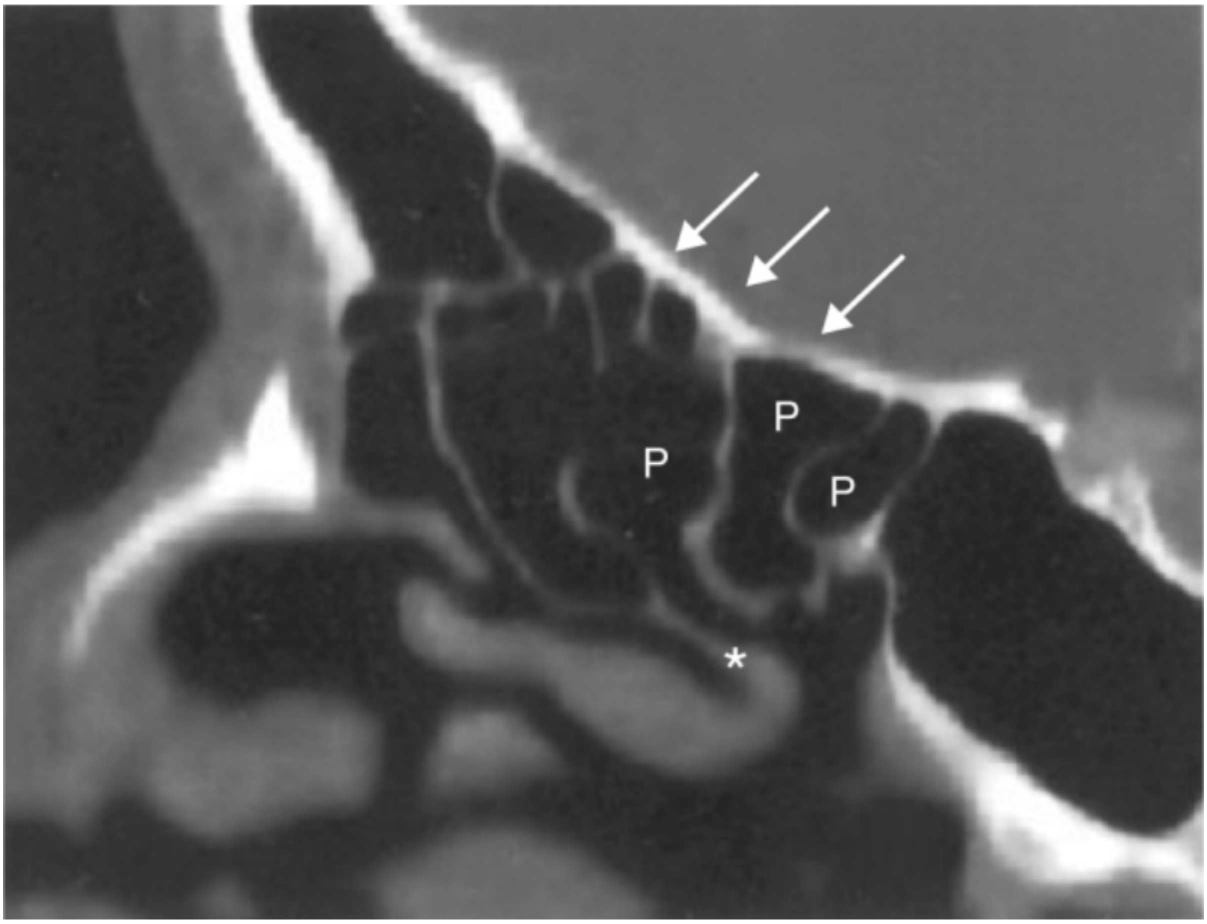

Figure 12-2 In this sagittal computed tomography section, the sloping of the skull base posteriorly is evident *(arrows)*. The posterior ethmoid cells and recesses drain above the middle turbinate and are identified with a *P*. The basal lamella of the middle turbinate is marked with an *asterisk*.

The anterior ethmoid cells are further divided into cells associated with the anterior ethmoid bulla and those associated with the frontal process of the maxilla. The anterior ethmoid bulla is either one or several cells and varies in size. It is identified just posterior to the middle and horizontal portion of the uncinate process. The space between the uncinate process and the anterior face of the ethmoid bulla is the hiatus semilunaris and represents the outflow tract of the maxillary sinus. Cells that form above the ethmoid bulla are termed *suprabullar cells*. If the anterior face of the ethmoid bulla extends superiorly to the skull base, then it forms the posterior wall of the frontal recess, if it does not insert on the skull base, then a suprabullar recess is formed. Agger nasi cells are present more often than not and are located just above the axilla or insertion of the middle turbinate and anterior to the uncinate process. Rarely, pneumatization of the tip of the uncinate may occur (Fig. 12-3).

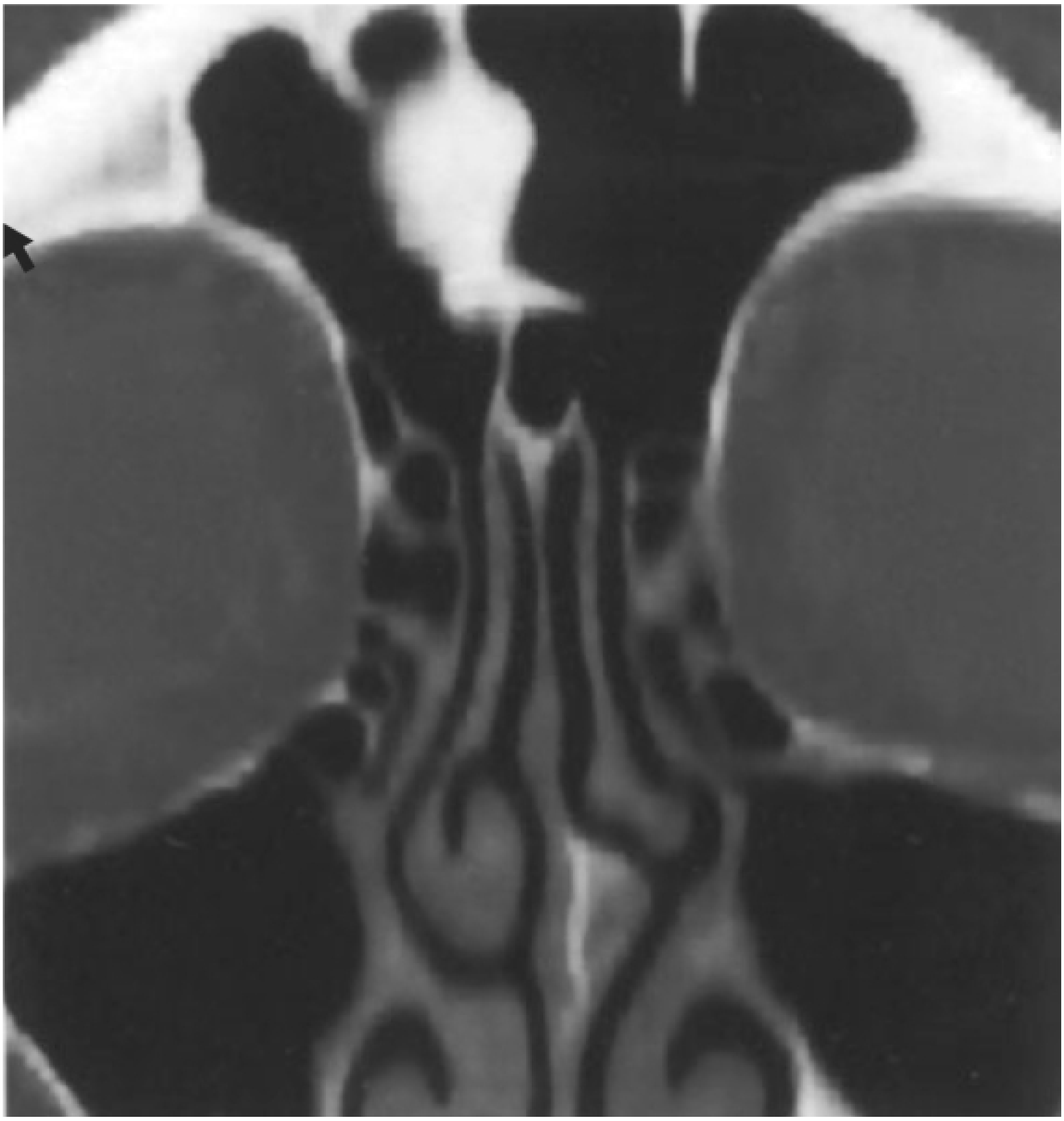

Figure 12-3 Stack of infundibular cells *(arrow)*, representing pneumatization of the uncinate. These cells occur anterior to the ethmoid bullae.

PATIENT SELECTION

Patients selected for ethmoidectomy should demonstrate symptomatic and irreversible mucosal disease, bony hypertrophy, or persistent opacity in the relevant ethmoid sinuses. Thus, an abnormality of the ethmoid sinus on review of the sinus CT scan is the usual prerequisite for endoscopic ethmoid sinus surgery directed at the abnormality. In general, hyperplastic mucosal abnormalities more frequently affect the anterior ethmoids and spare the posterior ethmoid cells. Ethmoid mucoceles, which can cause erosion of the lamina papyracea and produce orbital symptoms such as proptosis and diplopia, are usually secondary to scarring from prior surgery or associated with hyperplastic mucosal diseases such as allergic fungal sinusitis.[2]

An anterior and posterior ethmoidectomy may be performed to gain access to the sphenoid sinus, but this is not always required. Approaching the sphenoid via the posterior ethmoids preserves the vertical stability of the middle turbinate, which may be lost if the middle turbinate is lateralized to approach the natural ostium of the sphenoid, which usually lies medial to the middle and superior turbinate.

Approaches to the frontal sinus usually require extirpation of the agger nasi cells and frontal ethmoid cells, but usually do not require opening of the ethmoid bulla or associated suprabullar cells unless these anterior ethmoid cells unduly narrow the frontal recess and limit exposure.

Before surgery, symptomatic patients should undergo directed medical therapy. At a minimum, this usually includes culture-directed antibiotics given for as long as patients are steadily improving, nasal steroid sprays, a short course of systemic steroids, and occasionally topical antifungals or antimicrobials. Patients whose conditions warrant exception from a preoperative trial of medical therapy include those with impending orbital complications, those with mucocele, and those with unilateral disease in which a diagnosis is required to evaluate for diseases other than chronic nonspecific sinus inflammation.

PREOPERATIVE EVALUATION

Following a trial of medical therapy, if the patient remains symptomatic, then a sinus CT scan should be performed. Timing of the CT scan is critical. It should be performed to optimize delineation of irreversible disease. Sinus CT scans obtained when a patient has a cold usually show abnormalities that reverse with time. If a patient has a cold, the sinus CT scan should be rescheduled to coincide with the symptoms at baseline after directed medical therapy.

Most surgeons find the coronal sinus CT scan the most useful. The sinus CT scan is studied at the time surgery is recommended. If anatomic abnormalities exist that would be more safely approached with the use of computerized navigational technology, then this is arranged. The CT scan image should be available in the operating room at the time of surgery. Just before surgery, the sinus CT scan is again reviewed with special attention to the integrity and symmetry of the lamina papyracea, skull base, and sphenoid.

Patients should stop taking all aspirin for 10 days before surgery and all other nonsteroidal anti-inflammatories, vitamin E, and ginkgo biloba, which can all prolong bleeding, 7 days preoperatively. If there is a history of bleeding with prior surgery or trauma, then a coagulation profile is obtained. Profuse bleeding precludes safe endoscopic visualization and surgery and is a contraindication to continuation of an endoscopic dissection.

Preoperatively, patients are counseled regarding the procedure, risks, and complications. This informed consent should be detailed and include the following risks: loss of smell, worsening of symptoms, bleeding, infection, cerebrospinal fluid (CSF) leak, and orbital injury including diplopia and loss of vision. With endoscopic surgery directed at symptomatic objective disease, most series report that at least 85% of patients note an improvement in symptoms. Patients with nasal polyps should be apprised that the continued need for medical therapy postoperatively is common.

Patients with asthma frequently have hyperplastic sinus disease, which is also known as *nasal polyps.* Surgery should be postponed until their asthma is under good control. This may be facilitated with a preoperative prednisone taper. Under no circumstances should intubation be attempted during stage II anesthesia in an asthmatic patient, because this can provoke a life-threatening bronchospasm.

SURGICAL APPROACHES

Anesthesia and Patient Position

In the early days of ESS, local anesthesia with heavy sedation was the norm. It is still possible to operate with local anesthesia with or without sedation. In the office setting, revision ESS for patients with chronic hyperplastic sinus disease is frequently done using topical 4% Xylocaine alone and the microdébrider. Today, most patients undergo ESS as an outpatient procedure under general anesthesia. The surgeon should still use vasoconstrictors and topical anesthetic agents even under general anesthesia to minimize blood loss and general anesthesia requirements. The advantages of general anesthesia are protection of the airway from secretions/irrigations and elimination of the possibility of sudden movement by the patient, causing a surgical complication. Most practitioners, particularly those in teaching institutions, currently prefer general anesthesia.

The patient is positioned supinely under general anesthesia. For procedures performed in the office under local anesthesia, a sitting position for the patient is suitable. Increasingly, surgeons operate with the aid of a video screen. This allows for teaching and for better balance and less strained body position for the endoscopist. In the early days of ESS, all surgery was carried out with direct visualization through the endoscopes. Over time, this leads to shoulder and cervical neck strain in the endoscopist. The endoscopic sinus surgeon's goal is to position his or her body with minimal or no strain in conjunction with maximal body balance to most efficiently perform the procedure. This optimal positioning can be obtained in either a sitting or a standing position. We find a table height that is slightly lower than one's elbows to be the least fatiguing and most balanced in manipulating the video endoscope and instruments. We, like most right-handed endoscopists, prefer to stand on the right side of the patient. The video screen and computer navigational equipment, if used, are placed opposite the surgeon's eye, just to the left of the patient's head. An arm board or Mayo stand with cushioning towels may be used to support the left elbow, which controls the endoscope. A Mayo stand is placed at the head of the bed and is used to place materials for local injections and pledgets soaked in oxymetazoline. These pledgets are used for frequent repacking of the nasal cavity to augment vasoconstriction throughout the procedure. The anesthesiologist is stationed to the right of the patient and closer to the midsection and feet of the patient. Defog material is placed between the patient's head and the endoscopist so that the endoscope can be easily cleaned.

Preparation for Endoscopic Sinus Surgery

Preoperatively the patient's nose may be anesthetized and decongested as outlined in the endoscopic approach to the maxillary sinus. Variations include placement of synthetic sponges cut into thin strips measuring 3 to 4 cm by 1 cm and soaked in a 50/50 mixture of half 0.05% oxymetazoline for vasoconstriction and 4% Lidocaine for topical anesthesia after the patient is under general orotracheal or laryngeal mask anesthesia. Placement of the pledgets should encompass the middle meatus, the sphenoid recess, and the mucosa over the agger nasi cells. Pledgets are removed and replaced after injecting a total of 5 mL of 1% Lidocaine with 1:100,000 epinephrine divided between the left and right sides. Injections are placed at the most anterior attachment of the middle turbinate (sometimes called the axilla) and the central portion of the middle turbinate. If the posterior ethmoid cells or sphenoid sinus are to be addressed, then a spinal needle or long dental needle is used to inject the sphenopalatine artery area, which lies approximately 1 cm from the posterior edge of the middle turbinate in the middle meatus.

A transpalatal sphenopalatine block can be performed as an alternative to an endoscopic sphenopalatine injection. Before the endoscopic portion of the procedure, a tongue blade is used to depress the tongue and allow visualization of the palate, either with a headlight or the endoscope. The posterior edge of the hard palate is palpated with the index finger, which is then advanced forward until a subtle 1-cm depression half-way between the midline and the alveolar ridge at the level of the second upper molar is felt. Then a needle is bent, such that the straight shaft is not longer than 12 mm, and is used to inject 2 mL of 1% Lidocaine with 1:100,000 epinephrine. The needle should be directed slightly toward the occiput and should slip easily into its full length once the greater palatine canal is entered (Fig. 12-4). By bending the needle to 12 mm, insertion of the needle into the sphenopalatine ganglion is prevented. PJ Wormald and colleagues demonstrated a significant reduction in bleeding and improvement in visualization in a randomized, blinded, controlled study using this technique.[3]

Figure 12-4 Transpalatal pterygopalatine fossa injection. The greater palatine canal is halfway between the midline and the alveolar ridge at the level of the second upper molar. The needle is bent so that the straight shaft is no longer than 12 mm.

Following these injections, the surgeon scrubs and the scrub assistant drapes the patient. This allows sufficienttime to optimize vasoconstriction from the injection. If the nasal anatomy is insufficiently visualized with a headlight to allow injection, then the injections are performed endoscopically after the patient is draped and the endoscopic equipment is available. Beta blockade with metopolol preoperatively results in significantly less blood in the surgical field in patients whose pulse rate was less than 60 beats per minute compared with placebo-treated patients with higher heart rates. Whereas blood in the endoscopic field correlates with heart rate, it does not correlate with mean arterial blood pressure.[4]

Most surgeons now prefer to operate using a video camera. This facilitates the use of bulky instruments such as microdébriders, which are more easily manipulated if the surgeon's eye is not against the endoscope at the same time the surgeon is positioning the microdébrider beside the endoscope. The video image allows the surgeon to operate without undue strain on the neck, to monitor the surgery of a resident, and to demonstrate technique to others. Finally, video visualization allows for a second operator to assist whether through the positioning of the endoscope, liberating both hands of the surgeon, or by providing instrumentation such as suction or stabilization of tissue.

Use of Computer-Assisted Navigational Technology

Computer-assisted navigation allows for precise localization of instruments in ESS with the corresponding position on a preoperative sinus CT scan. This technology is particularly helpful in revision sinus cases in which landmarks are distorted or absent, in extensive nasal polyposis, for posterior ethmoid disease, and for disease abutting the skull base, optic nerve, or carotid artery (as in an Onodi cell). There are several commercial devices available. Computer-assisted navigational technology does not replace a thorough knowledge of anatomy. This technology is not required for most anterior ethmoidectomy cases.

Anterior Ethmoidectomy (Surgery of the Bulla Ethmoidalis, Suprabullar Cells, and Concha Bullosa)

In isolated anterior ethmoid disease, the endoscopic approach may be limited and consist merely of opening the ethmoid bulla anteriorly and medially and continuing the dissection posteriorly to include the ostia of the ethmoid bulla, which opens posteriorly in the retrobullar space. Some surgeons advocate placing an ostial seeker into the retrobullar space and probing for the ostia of the ethmoid bulla. Once this is found, the probe is used to fracture the posterior medial aspect of the ethmoid bulla cell forward. This fracture provides a point of purchase for a microdébrider to remove the anterior, medial aspects of the bulla and connect this opening with the bulla's ostia.[5] In hyperplastic sinus disease, the microdébrider is particularly useful for dissecting polyps from bony partitions. It may be difficult in hyperplastic sinus disease to appreciate the level of the ground lamella, the separation of anterior and posterior ethmoid cells.

In hyperplastic sinus disease, the surgery is no longer functional, and the goal is to marsupialize the cavities as widely as possible to facilitate postoperative irrigations and topical steroids and anti-infectives. Débriding a portion of the medial aspect of the middle turbinate with a microdébrider and the adjacent septum provides two adjacent raw surfaces. Placement of an absorbable or nonabsorbable pack in the middle meatus facilitates the contact and ultimately the scarring of the middle turbinate laterally. This may also be accomplished with a transseptal stitch.

The microdébrider should not be used with the open blade pointed laterally toward the lamina papyracea, because of the danger of inadvertent aspiration and removal of periorbita and even damage to the medial rectus muscle. If the microdébrider is used, the open blade should be directly visualized and pointed superiorly or medially. The microdébrider should not be used adjacent to areas of bony dehiscence in the skull base or orbit. Through-cutting instruments or plain suction is advocated in these areas.

Concha Bullosa

The presence of a concha bullosa is frequently an incidental finding and does not require surgery (Fig. 12-5). If, however, the concha bullosa is involved with hyperplastic mucosal disease, is persistently infected, is causing airway obstruction, or is limiting exposure to a diseased frontal, ethmoid, or sphenoid sinus, then it should be reduced. This is relatively easy with minimal risks. After injection of anesthetic with vasoconstrictors into the concha bullosa, a sickle knife is used to makea vertical incision in the concha. A Grunewald straight punch is opened and the upper arm is placed in the vertical incision, with the lower arm outside and below the concha bullosa. The instrument is closed and an inferior incision is thus made in the concha. The lateral aspect of the concha is removed with through-cutting instruments and the natural ostia of the concha is incorporated into the dissection. The microdébrider can be useful during this portion of the procedure. The vertical and medial portion of the concha is not destabilized. Under no circumstances, with the exception of tumors, is the superior medial aspect of the middle turbinate violated, because this can lead to olfactory impairment.

Figure 12-5 Note bilateral concha bullosa of the middle turbinate (*) and even pneumatization (#) of the tip of the uncinate. Also note the very uncommon anatomic insertion of the uncinate medially, which potentially allows the frontal sinus to flow directly into the maxillary sinus.

Posterior Ethmoidectomy

The posterior ethmoid cells drain into the superior meatus and their anterior extent is marked by the ground lamella of the middle turbinate. If a complete anterior and posterior ethmoidectomy is to be performed, then one usually performs a front to back technique, removing the anterior and then the posterior ethmoid cells. Because the skull base slopes posteriorly, with the more posterior aspect being several millimeters lower than the anterior skull base as it abuts the anterior ethmoid cells, perforation of the skull base at the level of the posterior ethmoids is more common than at the level of the anterior ethmoids (see Fig. 12-2). Knowledge and strict attention to this anatomic detail can prevent this complication.

Because it is unusual to have posterior ethmoid disease without concomitant anterior ethmoid disease, in the vast majority of cases an anterior ethmoidectomy is performed before a posterior ethmoidectomy. Once an anterior ethmoidectomy is completed (or in the rare circumstances in which posterior ethmoid access is desired without anterior ethmoidectomy), the posterior ethmoids can be safely entered by identifying the ground lamella of the middle turbinate. This is accomplished by advancing the endoscope in the middle meatus to the most posterior insertion of the middle turbinate, then withdrawing it anteriorly until the slope of the insertion of the middle turbinate transitions from horizontal to vertical. This represents the ground lamella. Ethmoid cells more posterior to this vertical aspect will empty above the middle turbinate, in the superior meatus. By inserting a probe, straight-biting instrument, or microdébrider at this vertical juncture, and by targeting the medial inferior aspect of this vertical plane, safe entry into the posterior ethmoid cells is assured.

Confirmation of entry into the superior meatus via an opening through the ground lamella and the posterior ethmoids is accomplished by identifying the anterior aspect of the superior turbinate. Alternatively, visualization of a Cottle elevator or suction inserted about 5 cm along the septum and medial to the middle turbinate can also confirm that one has opened into the superior meatus. This orientation can then be used in proceeding to a sphenoidotomy. A total posterior ethmoidectomy must follow close correlation with the preoperative CT scan. The skull base in this area is lower than the anterior ethmoids. Rarely does one identify the posterior ethmoid artery coursing across the roof of the posterior ethmoid cells.

Complete dissection of the posterior ethmoids is facilitated by navigation or close correlation with the preoperative sinus CT scan, particularly the sagittal orientation. At the level of the bony roof of the choana, one is in the sphenoid sinus. A posterior ethmoid cell that has pneumatized over the sphenoid (an Onodi cell) is marked by a horizontal septation overriding the sphenoid sinus on the coronal CT scan (Fig. 12-6).

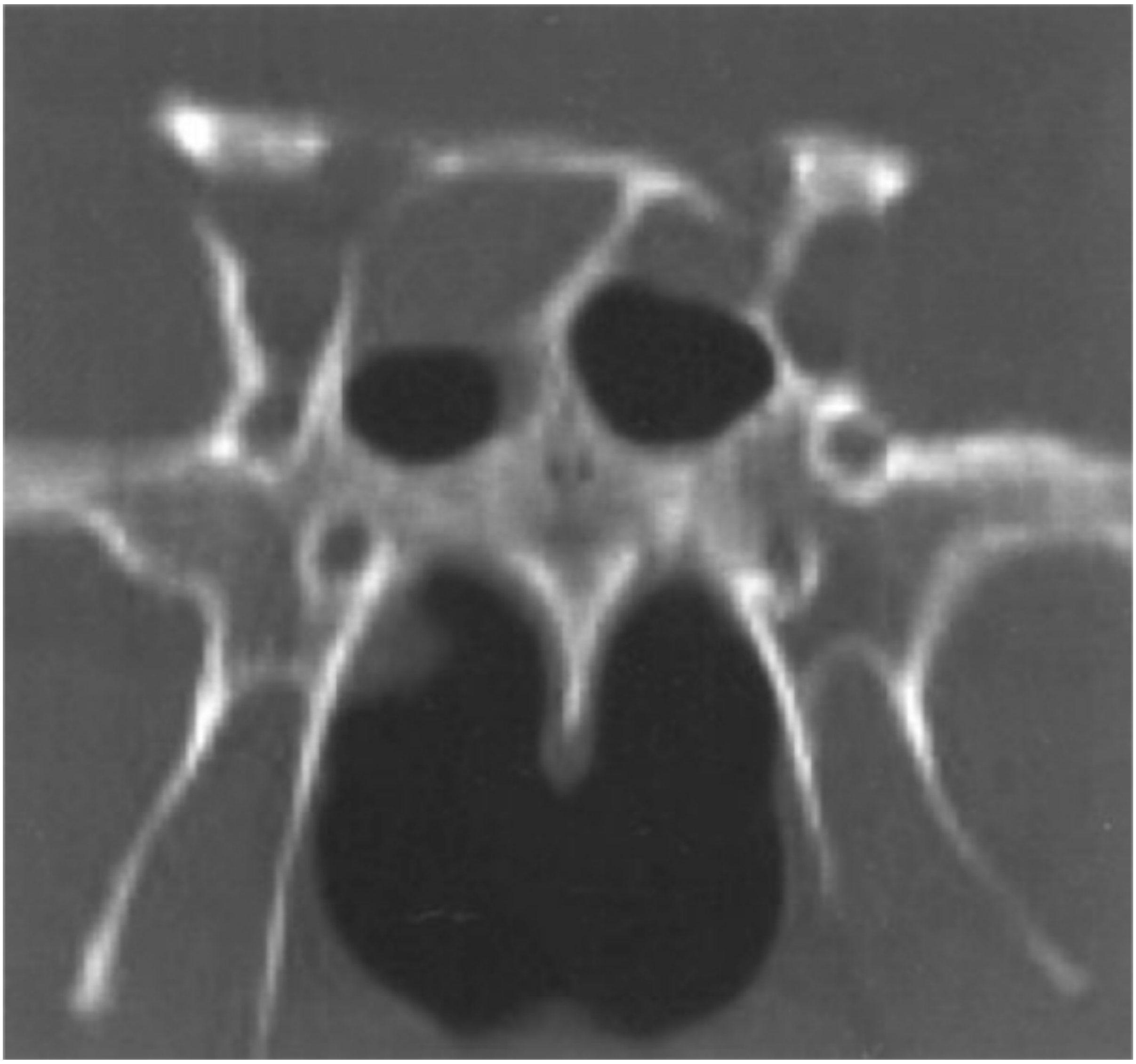

Figure 12-6 Coronal computed tomography scan demonstrating bilateral Onodi cells, also known as *posterior ethmoid cells,* which override the sphenoid sinus. In this case, the sphenoid sinuses are clear and the Onodi cells are opacified.

The sphenoid sinus is always the cell that is just above the bony roof of the choana. If there is a cell above this, then one has an Onodi cell variation. Pneumatization of this Onodi cell around the skull base in the region of the cavernous/carotid system and optic nerve can put these structures at the same risk surgically as when this occurs in the sphenoid. Moreover, appreciation of this Onodi cell variation is paramount if one is performing sphenoid surgery via a posterior ethmoid dissection.

Keros divided the anatomy of the ethmoid skull base into three divisions as outlined in Figure 12-7. Patients with a thin skull base, particularly at the junction of the lateral lamella and horizontal lamella of the cribriform are at increased risk for a CSF leak. Monopolar cautery should not be used adjacent to this area because it may cause a CSF leak.

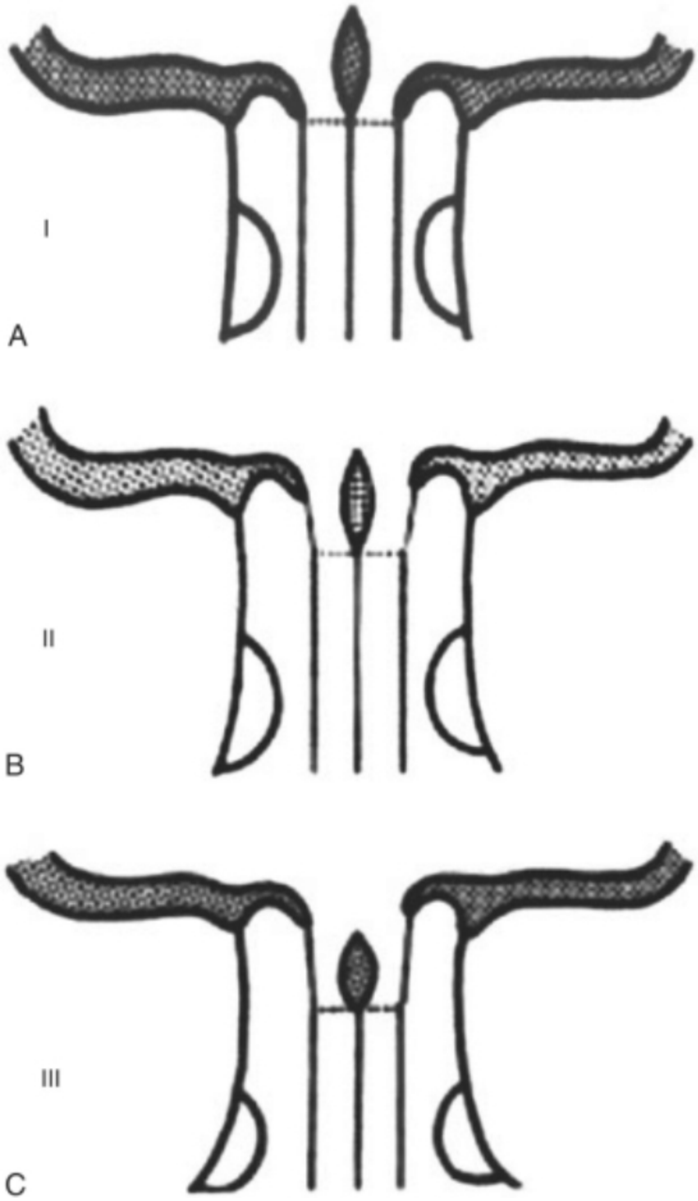

Figure 12-7 Keros classified the depth of the olfactory fossa into three types, depending on the length of the lateral lamella of the cribriform plate. **A,** Keros type I—Olfactory fossa as 1 to 3 mm deep and the lateral lamella is almost the same plane as our template. **B,** Keros type II—Olfactory fossa is 4 to 7 mm deep and the lateral lamella is longer. **C,** Keros type III—olfactory fossa is 8 to 16 mm deep and the ethmoid roof lies significantly above the cribriform plate.

(Modified from Stammberger H: Functional Endoscopic Sinus Surgery: The Messerklinger Technique. Philadelphia, BC Decker, St. Louis, 1991, p 75.)

At the end of the case, the cavity should be irrigated to remove clots and debris. Meticulous inspection and removal of all exposed bony spicules speed postoperative healing. Appropriate cultures and pathologic specimensshould be obtained. If this is a case with eosinophilic tenacious green to brown mucous plugs, then cultures for fungus and special fungal stains should be requested. If this is a unilateral case, then it is paramount that pathologic specimens be obtained for evaluation for inverting papilloma or other type of tumor.

POSTOPERATIVE MANAGEMENT

The postoperative management of ESS directed to the ethmoid sinuses is no different from ESS directed toward the maxillary sinus and there is a wide variation in follow-up. Packing may or may not be used, and increasingly the initial postoperative visit is in the following week or two postoperatively, unless patients have a pack or splint. These are removed immediately postoperatively to several days postoperatively. We routinely administer intraoperative antibiotics. There is no evidence that this is protective against the very rare complication of toxic shock syndrome postoperatively. Postoperative antibiotics should be directed by the sensitivities of preoperative or intraoperative cultures. Many patients with chronic rhinosinusitis do not have a bacterial etiology for their chronic rhinosinusitis and often respond more dramatically to potent anti-inflammatories, such as systemic steroids, than to antibiotics. If the patient has asthma or nasal polyps, we usually prescribe perioperative and postoperative steroids. In the operating room, 8 to 10 mg of Decadron is given intravenously along with an antistaphylococcal antibiotic such as cefazolin. Postoperatively, all patients who are asthmatic and who have nasal polyps are started on a prednisone taper with an initial dose of 50 to 60 mg each morning on postoperative day 1. This is tapered by 10 mg every 1 to 2 days, until the patient is off all systemic steroids, approximately 2 weeks postoperatively. By 2 weeks postoperatively, the postnasal drainage associated with sinus surgery is usually improved to the extent that it no longer endangers the lower airway by causing bronchospasm. Systemic steroids also provide the opportunity for the sinus cavities to heal during the postoperative period without recurrence of polyps.

Aggressive nasal irrigation with saline is initiated on the first postoperative day, if there is no obstructing packing. Aggressive irrigation, even with splints, can be helpful in keeping the nasal cavity and splints free of blood and debris. Irrigation is continued for a minimum of several weeks and sometimes indefinitely. Topical steroids may be added 10 to 14 days postoperatively and are usually given after the nasal wash. In refractory cases, irrigation with 20 to 40 mL of saline is followed by steroid solution irrigation or nebulization, such as 0.5-mg budesonide respules. Patients are followed up every week or so until entirely healed. Any scar bands, cysts, or debris are gently removed endoscopically following topical anesthesia of the nasal cavity with cotton pledgets impregnated with 4% Lidocaine and a small amount of oxymetazoline placed for at least 10 minutes.

Patients without hyperplastic nasal mucosa are discharged once they are sufficiently improved and entirely healed. Patients with hyperplastic nasal mucosa and nasal polyps are followed indefinitely, usually at least once every 3 to 6 months, because these patients are usually symptomatically insensitive to regrowth of their nasal polyps. If regrowth of the polyp is noted early, it may respond to such maneuvers as intrapolyp injection of 0.05 mL of steroids (such as triamcinolone acetonide 40 mg/mL) using a spinal needle. Care should be taken to only inject the avascular polyp, because rapid injection into vasculature such as is prominent in the turbinate tissue may lead to retrograde embolization into the retinal artery with associated permanent or transient visual loss.

PEARLS

- The sinus CT scan should be obtained once the patient has undergone directed medical therapy and is at symptomatic baseline.
- The sinus CT scan reviewed at the time surgery is recommended and again in the operating room, with special attention to the skull base, orbit, and any bony dehiscences and asymmetries.
- Aggressive postoperative irrigation by the patient with 20 mL of saline once or twice a day reduces the amount of postoperative office endoscopic débridement required.
- The ground lamella can be identified by endoscopically inspecting the posterior aspect of the middle meatus and coming forward until the slope goes from horizontal to vertical. Entering just below this junction ensures entrance into the posterior ethmoid cells.
- A posterior ethmoid cell that pneumatizes over the sphenoid sinus (an Onodi cell) can be adjacent to the optic nerve or cavernous/carotid complex.

PITFALLS

- If the monopolar cautery is used adjacent to the cribriform plate at the entry point of the anterior ethmoid artery, it is likely to cause a CSF leak.
- Use of the microdébrider adjacent to the lamina papyracea or skull base, especially if there is a bony erosion or impaired visibility, is likely to irrevocably destroy extraocular muscles or dura.
- Induction of elective general anesthesia for ESS in the poorly controlled asthmatic patient may cause severe bronchospasm and even death.
- Failure to obtain an informed consent regarding common and rare complications, such as orbital injury, CSF leak, and loss of smell, makes legal defense of such complications difficult.
- If the middle turbinate is transected close to the skull base, then loss of olfaction is likely to occur.