CHRONIC ETHMOID SINUSITIS

The method of
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Although the perception of the anatomy of the ethmoid bone is one of infinite complexity, the reality is that the basic components are in fact only four: the ethmoidal bulla, the agger nasi cell(s), the sinus lateralis, and the posterior ethmoid cells. The former two components represent the bulk of what is known as the anterior ethmoid complex. The sinus lateralis is not a cell, but a space of quite variable location and dimensions posterior to the bulla. It may be thought of as a pneumatized portion of the basal lamella, a lateral reflection of bone from the middle turbinate to the lamina papyracea and the bony reference used to divide anterior from posterior cells. The variation in the configuration of the basal lamella is largely a function of the location and extent of the sinus lateralis. The basal lamella may be pneumatized in any combination of the four quadrants of its vertical portion. The inferior horizontal portion of the basal lamella is not so pneumatized.

All of the aforementioned in conjunction with the uncinate process, lamina papyracea, middle turbinate, and portions of the skull base are, to the anatomist, one, and only one, bone: the ethmoid bone. The variations on the basic architecture of the ethmoid bone, as any experienced endoscopist will confirm, are almost legion and may be further altered by the disease process. Consequently, the surgical anatomy defies a predictable configuration, allowing only generalizations about surgical landmarks. However, the components of the surgical anatomy of the ethmoid bone are, although variable in configuration, constant enough that an anatomic dissection is both possible and desirable.

The variations in the sinus lateralis and basal lamella have been addressed. The ethmoidal bulla may be single or tiered. It may or may not have a back wall in addition to the basal lamella posteriorly. The agger nasi, the most anterior and superior cell of the basic architecture, may also be tiered, and, more important, it may pneumatize the frontal bone as well. Cells from either the anterior or posterior complex, if one considers the drainage pattern, may pneumatize the middle and/or superior turbinate. A variation of posterior ethmoid cellular development is a pneumatized extension beyond the face of and over the sphenoid sinus, the Onodi cell.

The boundaries of the anterior and posterior ethmoid complex are the lamina papyracea laterally, the skull base superiorly, and the middle turbinate medially. Absent the Onodi cell, the face of the sphenoid sinus is the posterior limit of the complex. If the skull base is dissected, neurovascular bundles, both anterior and posterior, may be seen traversing the skull base from medial to lateral. The drainage for the frontal sinus is frequently found immediately anterior to the anterior ethmoid bundle.

Spaces relating to the ethmoid are the middle meatus, the hiatus semilunaris, the infundibulum, the hiatus semilunaris posterior, the superior meatus, the sphenoethmoid recess, and the space into which the frontal sinus drains. The infundibulum is a three-dimensional space anterior to the ethmoidal bulla and bounded otherwise by the lamina papyraeca laterally and the uncinate process medially. The hiatus semilunaris is a two-dimensional space defining the most medial extent of the infundibulum between the bulla and the posteromedial extent of the uncinate process.

The hiatus semilunaris posterior is bounded by the medial wall of the bulla, the lateral aspect of the middle turbinate, and the vertical portion of the basal lamella posteriorly. The superior meatus is a recess beneath and lateral to the superior turbinate. The sphenoethmoid recess is a space of varying dimensions at the most posterior extent of the interface between the middle turbinate and the nasal septum The most common drainage pattern for the sphenoid sinus is into the sphenoethmoid recess. Although the ultimate drainage for the frontal sinus is dictated by the insertion of the uncinate process superiorly, the most common pattern of egress from the frontal sinus is into the space posterior and medial to the agger nasi cell.

■ PATHOGENESIS

Even though honest observers may differ about the aforementioned designations and definitions, there is now little argument about the location of the initiating event in the pathogenesis of sinusitis. The location is anterior with respect to the ethmoid bone, and, as will be discussed, most likely in the infundibulum and/or the hiatus semilunaris posterior. The sinuses most often involved early in the disease process are, as expected, the anterior ethmoid and maxillary sinuses. Seldom do the posterior ethmoid or the sphenoid sinuses initiate difficulty and clinically seem to be reluctant participants in the disease process.

One possible explanation for the difference in susceptibility between the anterior and posterior sinuses is to be found in the marked difference in their respective drainage patterns. The posterior sinuses have the luxury of a direct entry into the nose, the posterior ethmoid via the superior meatus, and the sphenoid into the sphenoethmoid recess. By contrast, both the maxillary and ethmoidal bulla drain into transition spaces that subsequently empty into the nose. The transition space for the maxillary sinus is the infundibulum. For the ethmoidal bulla, drainage in most instances exits from a posterior and medial opening into the hiatus semilunaris posterior before it actually enters the nasal cavity.

Another way to underscore the significant difference in the entry of the anterior and posterior sinuses is that the openings for the sphenoid and posterior ethmoid sinuses may be visualized by simple endoscopy, which is in marked contrast to the hidden entry of their anterior neighbors. In the absence of a more plausible theory of the pathogenesis of sinusitis, the transition spaces of the anterior sinuses (the infundibulum and hiatus semilunaris posterior), and not the sinuses themselves or even their ostia, may well be the location of the initiating event and thus the cause of the difficulty. If an extension of this theory includes, in most in-

stances, that the disease within the sinuses is not end-stage and thus not deserving of removal, surgery limited to the elimination of the transition spaces may well suffice, even in the presence of advanced pathology The anterior sinuses would then enjoy the direct entry of the less susceptible posterior sinuses. Removal of the posterior-medial wall of the agger nasi cell serves the same purpose for the frontal sinus.

■ PREOPERATIVE PREPARATION

Selecting the patient for sinus surgery is more a function of the art and not the science of medicine. Most otolaryngologists who formerly hoped that the information on the computed tomographic (CT) scan of the sinuses would make the decision an objective one now know that the information factored into the decision to operate or not must be ultimately obtained from the patient. Although many variables must be considered, two final determinations are decisive: (1) Is the patient miserable enough, or is the situation dire enough to justify operative intervention? (2) Are medical options no longer attractive, or have they been exhausted, or does the situation preclude resolution via conservative measures? Under this model, CT scan is essential for the actual surgical intervention, and it is considered a bonus if there is good correlation with the clinical findings.

The preparation of the patient before going to the operative suite is critical to both the patient's and the surgeon's experience. Inquiry regarding the ingestion of salicylates and/or nonsteroidal anti-inflammatories should be made enough in advance to allow a 10 to 14 day abstention.

Local Anesthesia and Hemostasis

I use serial 0.05 percent oxymetazoline sprays followed by serial sprays of a 10 percent cocaine and 1:1,000 (1:50,000 when delivered as spray to patient) epinephrine mix. The combination delivers both a profound vasoconstriction and topical anesthesia, and no significant systemic responses have been observed in either children or adults. The surgeon enjoys an immediate access to the nasal cavity under local or general anesthesia and can begin surgery without a "pack and wait" interval.

There appears to be no valid argument to support anything more than a theoretic advantage for operating in a sitting or a standing position. Neither is there a conclusive argument that operating off the monitor or through the endoscope is more beneficial for patient or surgeon. Better arguments obtain, particularly in ethmoid surgery, for implementing a variety of measures to minimize bleeding. They include both a hypotensive technique and a low end-tidal CO_2 when operating under general anesthesia.

Other measures apply to both local sedation and general anesthesia cases and include care not to traumatize the septum or lateral nasal wall when introducing the needle for injections. In most instances, leading with the needle in advance of the endoscope obviates this concern. Lateral wall injections of limited number and not along the path to the middle meatus are also helpful. Leaving mucous membrane at the limits of the dissection serves the dual purpose of reducing both bleeding and the healing burden for the patient. Where feasible in general anesthesia cases, early extubation will reduce immediate postoperative blood loss.

■ SURGICAL TECHNIQUE

The actual surgical technique delivered is the result of the combination of the surgeon's philosophy and the chosen instrumentation. Both will impact the degree of bleeding during the procedure. As mentioned, if mucous membrane of any degree of pathology is retained in lieu of the exposure of bare bone, both the amount of bleeding and the healing burden of the patient are reduced. Instrumentation, such as powered instrumentation, which delivers both precision and real-time suction brings advantages not available otherwise.

A precision cutting technique has obvious advantages over the traditional "grab and tear" approach coupled with the burden of removing all diseased tissue. I have no experience with the recently available "cutting" instruments.

Advances in both visualization and instrumentation have brought the issue of the necessary extent of sinus surgery to the forefront. The issue is especially applicable to intervention in the ethmoid complex. If ethmoid sinus disease begins in the hiatus semilunaris posterior, removal of the medial wall of the ethmoidal bulla eliminates the transition space of the bulla and provides direct entry into the nasal cavity. The removal must extend posteriorly to include marsupialization of the opening from the bulla into the hiatus semilunaris posterior. If the bulla is tiered, there may be an opening for each cell. Absent the cause of the disease, progressive improvement may then be expected without the necessity of removing all diseased tissue from the bulla. Surgery is therefore directed toward the cause of the disease rather than the disease itself.

Agger Nasi

Surgery for disease in the other component of the anterior cells, the consistently present agger nasi cell(s), is a function of removing the upper portion of the uncinate process to access the cell from below. The approach to the cell(s) is much more posterior than the location of the agger nasi would indicate by endoscopy or CT findings. The uncinate must be removed from posterior to anterior, working both superiorly and laterally. As with the maxillary sinus and ethmoidal bulla, neither the agger nasi cell nor its exit for egress may be seen at simple nasal endoscopy.

Upon entering the cell, both the opening from the cell and the space behind the posterior and medial wall can be visualized with a 30 degree endoscope. Surgery is limited to marsupialization of the cell and its outflow tract, leaving the mucous membrane intact and where indicated, removing the posterior-medial wall of the cell to open the transition space for the frontal sinus. An extended pneumatization from the agger nasi cell into the frontal bone is not unusual and may compromise frontal drainage, which dictates a more extensive removal of the posterior and medial wall.

Middle Turbinate

If the middle turbinate is pneumatized, the cell(s) are subject to the same disease processes as other ethmoid cells. In addition, nasal obstruction and compromise of drainage path-

ways when the turbinate is enlarged greatly are frequently present. The lateral aspect of the cell may closely contact the lateral nasal wall, uncinate process, and ethmoidal bulla. The precise removal of the lateral portion of the cell is possible without the necessity for sacrificing the bulk of the turbinate or removing the lining from the residual medial portion. The most common exit for the cell if it is completely enclosed is posterior and medial into the middle meatus or hiatus semilunaris posterior. In such cases, the marsupialization of the cell must include the opening of the outflow tract as well. However, the medial lip of the opening is retained.

Alternatively, the drainage for a pneumatized middle turbinate may be the superior meatus, in which case the lateral wall of the cell within the middle turbinate will reflect posteriorly and laterally to become the basal lamella, and the cell itself may be followed posteriorly as the most medial portion of the ethmoid complex, with egress into the superior meatus and extension posteriorly to the skull base, Surgery is thus limited to the marsupialization of the cell and retention of mucous membrane unless the basal lamella is taken down to address posterior disease.

Extensive intervention for both anterior and posterior ethmoid disease has been reported by many observers to be therapeutic. In most instances, all cells are marsupialized, all partitions are removed, and most, if not all, diseased tissue is removed. The middle turbinate is frequently sacrificed as part of the procedure, Currently, surgeons performing such extensive surgery are advising caution about extensive tissue removal with the exposure of bare bone, suggesting retention of mucous membrane along the lamina papyracea and at the base of the skull. As discussed next, an argument may be made that perhaps even less intervention than currently recommended would suffice, particularly with respect to the posterior ethmoid cells.

Posterior Cells

If the anterior cells are the first to participate in the disease process, the posterior cells are surely the last. Even in the face of extensive disease anteriorly, the posterior cells are frequently minimally diseased, if at all. The reason or reasons for the discrepancy are not clear, but the only significant difference other than the location within the skull is the direct entry of the posterior cells as opposed to the previously described entry of the anterior neighbors. The posterior cells are thus "last in" in terms of participating in the disease process. If they become involved secondarily, perhaps clearing of the disease anteriorly would reverse the process, allowing them to be "last out," thus obviating the need for surgical intervention at all. At most, intervention should be limited to the removal of secretions and/or polyps without the stripping of mucous membrane and exposure of bare bone. The limited number of cells and their relatively larger size are quite conducive to this surgical approach.

Ostia

With no evidence of a minimal threshold size for sinus openings into the nose and with abundant evidence that, in most instances, small holes function very well, respect for the ability of sinuses to function with a small outflow tract serves both patient and surgeon well. However, in the presence of fungal sinusitis, the requirement to remove all of the fungal debris, but not the underlying mucous membrane, dictates that adequate openings be made to accomplish that goal. The degree of surgery needed in such cases will vary from case to case and is a judgment decision for which no surgical guidelines exist. Secondary surgery for fungal sinusitis is the rule inasmuch as the marsupialization and removal of debris from every cell at the primary sitting is a goal seldom achieved.

Postoperative Care

The recommendations for postoperative care following surgery in the ethmoid complex are as diverse as the surgery itself. A full spectrum of postoperative management from skillful neglect with or without nasal irrigations or sprays to meticulous "clean-outs" have been reported to produce comparable results. Spacers of various types to no spacers of any kind are reported to produce equally favorable outcomes.

The minimally invasive surgical approach described in detail in prior studies (and briefly here) has been in continuous use for more than 1,500 consecutive patients since February 1993. Postoperative management consists of a Gelfilm roll in the middle meatus to be removed at 10 to 14 days. No nasal packing is used, even if a septoplasty with resection is done. Both intraoperative intravenous and postoperative intramuscular steroids are given. Irrigations with a hypertonic buffered saline solution at body temperature are begun in 24 hours in conjunction with the use of postirrigation nasal steroids. Noseblowing is allowed from the outset, and no restrictions are placed on diet or activity.

Outpatient surgery under monitored sedation is the rule when the surgery is limited as described previously. Further, most patients return to preoperative activity levels within 24 to 48 hours. There are no scheduled return visits until 10 to 14 days, which is in obvious disagreement with the early admonitions regarding the necessity for early postoperative crust removal. Early healing is to be expected and indeed occurs given the low healing burden associated with limited intervention and minimal bare bone in the surgical wound. Many patients are discharged on an as-needed status for the first postoperative visit. Apart from the presence of nasal polyposis in association with fungal disease, the necessity for secondary surgery has been reduced from 15 percent to 5 percent.

Suggested Reading

Setliff RC 3rd. The small-hole technique in endoscopic sinus surgery. Otolaryngol Clin North Am 1997; 30:341-354.

Setliff RC 3rd. Minimally invasive sinus surgery: The rationale and the technique. Otolaryngol Clin North Am 1996; 29:115-124.