Section 2

Management of Inflammatory Sinus Disease

Chapters

CHAPTER

9

Basic Functional Endoscopic Sinus Surgery

Spencer C Payne

PHILOSOPHY AND APPROACH

As we have discussed previously, chronic sinusitis and other disorders of the nose and paranasal sinuses exist along a spectrum of severity and difficulty. It would thus be unreasonable to expect that any one method of surgery or extent of dissection could be proscribed for all patients. The functional part of endoscopic sinus surgery requires that efforts are made to preserve as much of the natural structure of the sinuses as can be while ensuring that the anatomy that either obstructs the sinus or prevents adequate debridement or topical application of medication is removed. In the next chapters, we will discuss the options for the patient who has failed primary surgery (Chapter 10) and when minimal surgery can be effective through balloon dilation (Chapter 11). In this chapter, the focus will be on performing complete, but logical dissections of the paranasal sinuses and it is the expectation that the surgeon will reduce or expand the extent of dissection as mandated by the underlying disease.

What is important for any surgery, especially endoscopic sinus surgery, is that a preoperative plan be established based on patient factors and anatomical issues identified on the CT scan and that this plan be executed in an organized fashion. Essential to this goal is the identification of landmarks on the CT scan that can be translated to the patient's endoscopic exam such that they can be referred to often during the procedure. It is important preoperatively to note the location and status (dehiscent or not) of the ethmoidal arteries, the presence of Haller or Onodi cells, the slope of the skull base (both in the AP and lateral dimensions) and the complexity of the ethmoid pneumatization. Once these points have been established and a plan has been created, the surgery can begin.

O.R. SETUP AND PATIENT POSITIONING

The operating table should be turned at least 90°–180° away from the anesthesia cart to provide sufficient room for the surgeon and the equipment (Fig. 9.1). The right handed surgeon will find it easiest to be on the patient's right side with the scrub and back table across the patient on their left side. The video cart should be positioned at around the 1 or 2 o'clock position to facilitate an ergonomic view. The IGS tower, if being used, can be positioned either to

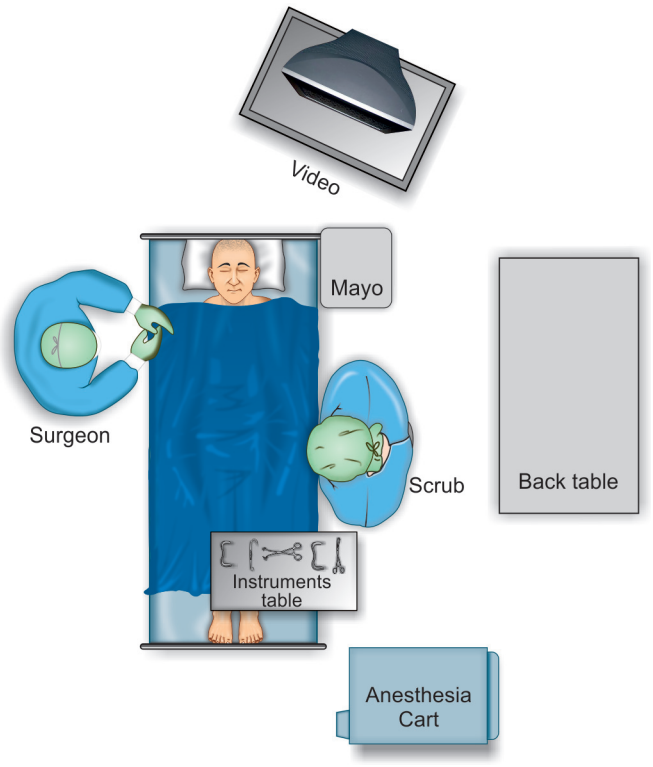
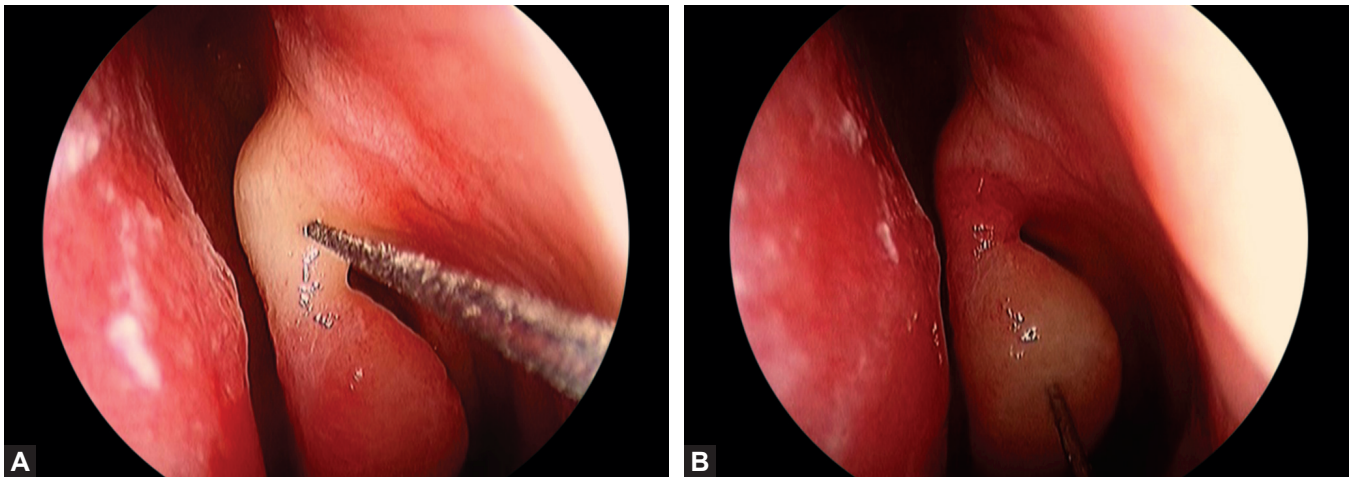


Fig. 9.1: Room positioning.



Figs. 9.2A and B: Injection sites for basic endoscopic sinus surgery. (A) At the root of the middle turbinate; (B) inferomedially on the head of the middle turbinate. If possible, a third injection can be placed posteriorly near the edge where the sagittal component of the turbinate transitions to the axial.

the left or right of the video tower depending on room size and surgeon preference. Appropriate reversal of this setup can be utilized for the left-handed surgeon.

Before draping, any anesthetic monitoring cables are elevated off the floor and secured to the bed to minimize discomfort and optimize the operative area for standing or sitting. Once draped, the various cables (light, endoscope, and powered instrumentation) and suction tubes are secured to the bed. This prevents movement during the case, which can often limit the maneuverability of the surgeon's hand as the cables can be weighty.

As was noted in Chapter 6, positioning of the patient can greatly improve visualization of the sinuses by decreasing blood loss.[1] Either the head of bed can be elevated or the patient is placed in a reverse trendelenburg position of about 20°–30° in order to reduce central venous pressure and subsequent venous and capillary bleeding.

BEFORE THE SURGERY

Nasal Preparation

Preparation of the nose begins in the preoperative suite with three applications, separated by 5–10 min, of oxymetazoline sprays. In the operating room, once general anesthesia has been induced, the nose is packed with oxymetazoline-soaked pledgets under direct inspection. It is unlikely to be able to place these in the middle meatus primarily at this point and so effort is made to atraumatically place them in the anterior nasal cavity. This enhances the decongestant effect on the septum and turbinates, which had previously been initiated in the preoperative suite. There is debate regarding the appropriate vasoconstrictor in sinus surgery.[2] The safest overall is oxymetazoline which is why we generally use it preferentially and phenylephrine should be avoided. Topical epinephrine, used 1:1,000 to 1:5,000 can be employed for better hemostasis but the surgeon is cautioned to avoid in patients with cardiac history and to employ mechanisms and/or protocols to guarantee against accidental injection (such as coloring with fluorescein). After draping, the nose is injected with a focus on the middle turbinate in three locations:

- Over the axilla at the junction of the turbinate and the lateral wall with medial positioning to help guide any bleeding from the injection site away from the middle meatus (Fig. 9.2A)
- Inferomedially on the head of the middle turbinate and (Fig. 9.2B)
- Posteriorly along the inferior aspect of the turbinate (not shown).

Additionally, if the uncinate is visible direct injection of the uncinate can be accomplished, otherwise gentle medialization and placement of a vasoconstrictor-soaked pledget is performed. The vestibular vibrissae are then trimmed. This helps minimize collection of blood at the nostril, which can stain the endoscope during removal and reinsertion throughout the case.

Effective Nasal Cleaning and Suctioning

After sufficient time has elapsed, usually upon completion of equipment setup and a time-out where the surgical

plan and patient specific concerns are discussed amongst members of the operative suite team, the nose should be suctioned and the procedures commenced. As simple an act as nasal suctioning can play a large role in minimizing trauma to the nose. At this early point and throughout the case, care should be taken to enter the nose carefully without applying any suction and proceed first to the nasopharynx, which often serves as the reservoir for saliva, mucous and blood. Suction is then applied and blood is cleared from the nose from posterior to anterior. In this manner, the often times sharp edge of the suction is less likely to cause inadvertent trauma. It is also important to not dwell on cut surfaces throughout the case but focus only on removing blood pools and not areas where coagulation has already occurred as this may disrupt the clot and reinitiate bleeding. Instead warm saline irrigation (104°F) can be a miraculous adjunct for the surgeon to deal with areas of persistent oozing.

Nasal Inspection

After the nasal preparation is complete, the nose is inspected and the need for a septoplasty is further assessed. For optimal surgery, good access to the middle meatus is essential, especially if frontal sinus exploration is to be performed. Pay close attention to whether superior dorsal deflection, often at the superior most portion of the bone-cartilaginous junction of the turbinate, prevents access or visualization of the axilla of the middle turbinate (Fig. 9.3). Consider as well that the appearance of the nose after such significant decongestant during the preparatory phase may underrepresent the access in the postoperative nasal cavity for inspection and/or debridement. If necessary, an endoscopic septoplasty can be performed (Chapter 13). Otherwise, note is made of the presence of purulence, polyps, or other anatomical issues that may require addressing.

FESS BASIC CONCEPT

As we learned in Chapter 3, the ethmoid complex derives from a numbered series of ethmoturbinals (ETs), which despite some variability, result in several consistent landmarks. For a complete unilateral sinus surgery, we subscribe to the anterior–posterior, posterior–anterior approach given its orderly progression and demonstrated safety.[3] If followed from anterior to posterior, in order, the identification and dissection of these ET derivatives creates an organized and orderly progression for surgery and forces the surgeon to consider the next step in terms

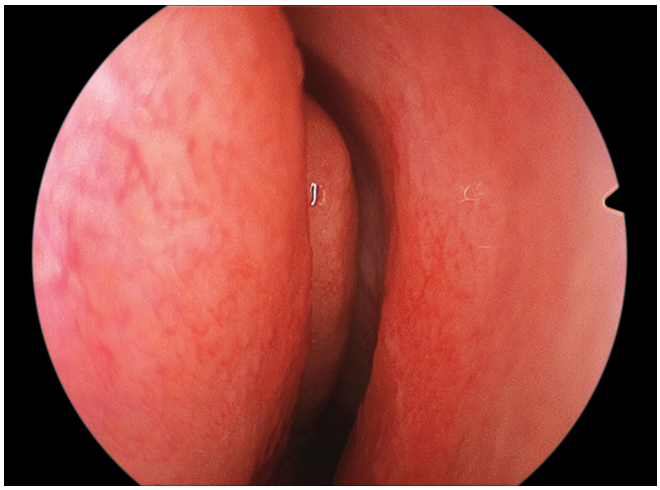


Fig. 9.3: Septal deflection prevents access to the middle meatus. Consider an endoscopic septoplasty to address.

of defined anatomy. The first of these derivatives is the uncinate process (ET1). From there, we move on to the identification and dissection of the ethmoid bulla (ET2), basal lamella of the middle turbinate (ET3), and finally the superior turbinate and posterior ethmoids (ET4). The sphenoid sinus is then opened, if necessary, and the skull base is identified. A posterior-to-anterior approach is then performed and septations are removed superiorly along the ethmoid roof as we work our way back towards the frontal sinus.

The use of powered instrumentation for sinus surgery was introduced in the mid 1990s. The benefits are continuous suctioning and a consistently sharp instrument, but with the significant drawback of substantial iatrogenic injury occurring quickly due to its standard 3,000–5,000 rpms. As a result, several methods of integrating its use into sinus dissection have evolved including restricting it to polypectomy alone, using it to clean up the "mucosal soup" left over from nonpowered dissection (to borrow a phrase from Richard Harvey), or as the primary means of dissection. It is our practice to utilize it as the primary means of dissection. The reader is cautioned, however, as this is often difficult for the beginning surgeon as this requires "intimate" knowledge of the best angles, directionality of force application, and tip manipulations in order for the microdebrider to take the place of multiple instruments that have all been specially designed for distinct purposes. As such, the basic steps for the dissections will be described and where appropriate, pointers for powered and nonpowered options provided.

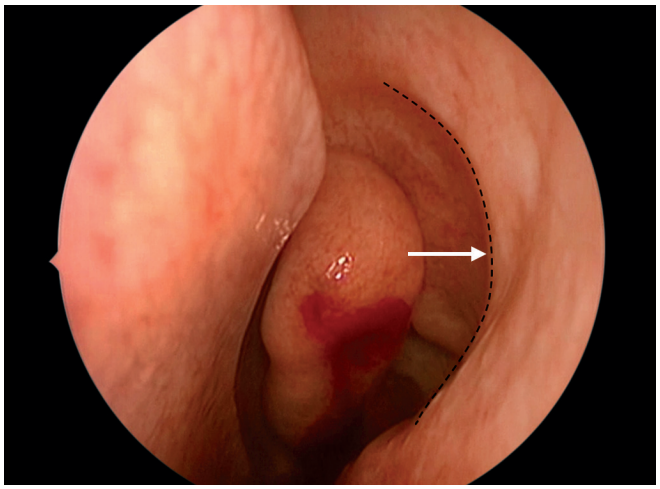


Fig. 9.4: The maxillary line. The dashed line corresponds to the maxillary line, the junction of the uncinate to the ascending process of the maxilla and denotes the underlying lacrimal suture. It serves as the absolute anterior border of any uncinectomy. Also note the "shaded" trough posterior to this (arrow), which is likely the anterior most extent of the ethmoid infundibulum.

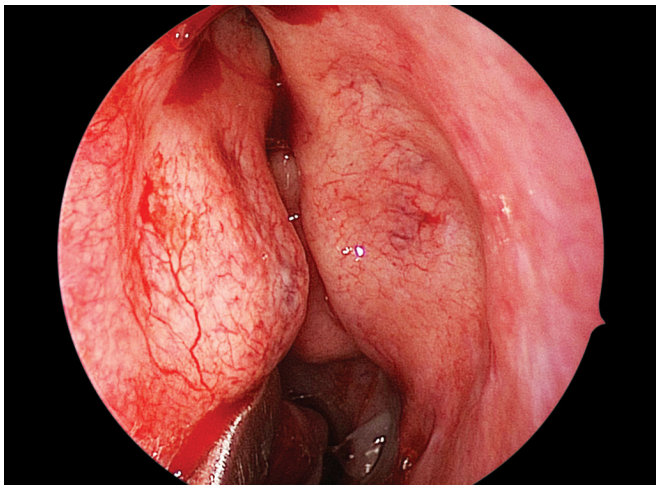


Fig. 9.5: Middle turbinate medialization. The convex side of an elevator is used to displace the turbinate such that the ethmoid bulla and uncinate process can be easily identified.

UNCINECTOMY AND MIDDLE MEATAL ANTROSTOMY

Given the variability of the pneumatization of the ethmoid sinuses and frontal sinus outflow configurations, the maxillary sinus, along with the sphenoid, is one of the most important consistencies in sinus surgery. Its roof can lead you to the lamina and serve as a guide for the appropriate trajectory to the sphenoid sinus. As such, its opening at the beginning of most sinus cases serves an important role. Original descriptions of maxillary antrostomies included starting in the posterior fontanelle or using sickle knives to incise the uncinate anteriorly. We, however, prefer to utilize a back-biter to incise the uncinate in a retrograde fashion as this is less likely to result in either the secondary-ostium/recirculation phenomenon or accidental injury to the orbit or lacrimal sac seen with these older techniques.

The procedure starts with identifying the maxillary line that helps to identify the attachment of the uncinate to the maxilla and the location of the lacrimal suture (Fig. 9.4).[4] Along with the anterior head of the middle turbinate, these landmarks denote the anterior most extent of any uncinectomy such that iatrogenic injury to the lacrimal sac and duct can be avoided. In reality, the deepest portion of the trough often apparent just posterior to this line and also noted in Figure 9.4 is usually the anterior most extent of the ethmoid infundibulum and a good reference for how far anterior one can incise the uncinate.

Surgical Steps

- Use Freer or blunt side of Cottle elevator to medialize the middle turbinate and visualize the uncinate and ethmoid bulla (Fig. 9.5).
- Optionally a vertical relaxing incision can then be made in the posterior aspect of the meatus medial to the inferior aspect of the ethmoid bulla in the basal lamella of the middle turbinate as this has been shown to improve access and reduce trauma in cases where limited anterior surgery is to be performed (Fig. 9.6).[5]
- A pediatric or microbackbiter (Fig. 9.7) is then inserted into the middle meatus while closed, opened superiorly, and rotated into position behind the uncinate at a level approximately even with the inferior aspect of the ethmoid bulla, which will roughly divide the uncinate into its superior 2/3rd and inferior 1/3rd. This division typically represents the level at which the natural ostium can be found anteriorly (Fig. 9.8). This technique may require modification in the setting of differently positioned uncinate processes (Figs. 9.9 and 9.10).
- Gentle medial traction is placed on the uncinate before each bite to gauge its mobility and anterior attachment in order to minimize iatrogenic injury to the lacrimal apparatus while maximizing uncinate removal.
- The backbiter is serially closed, opened, advanced anteriorly, and closed again until the anterior aspect of the infundibulum is reached (Fig. 9.11).
- The area is suctioned to ensure a full three-layer incision was created and then a maxillary ball probe

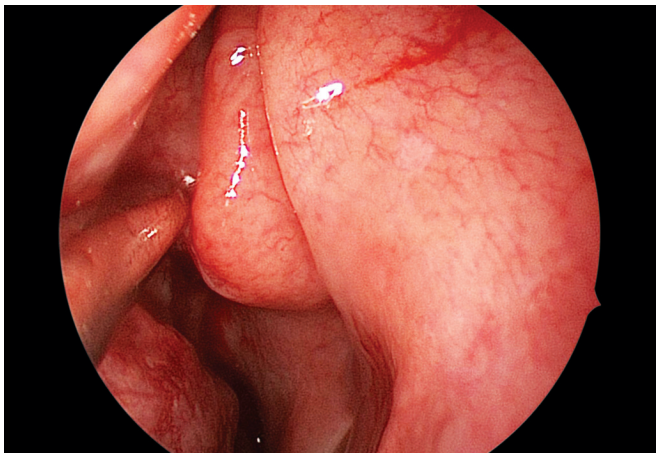


Fig. 9.6: Site of basal lamella relaxing incision. This is an optional step that may be necessary if gentle medialization does not allow for persistent displacement of the turbinate.

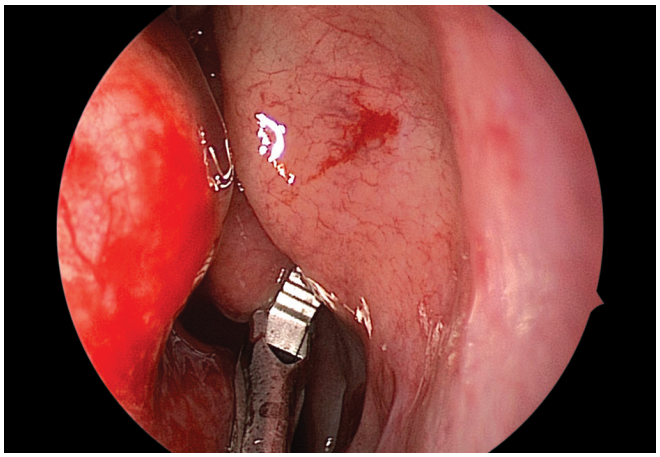


Fig. 9.7: Backbiter positioned behind the uncinate process.

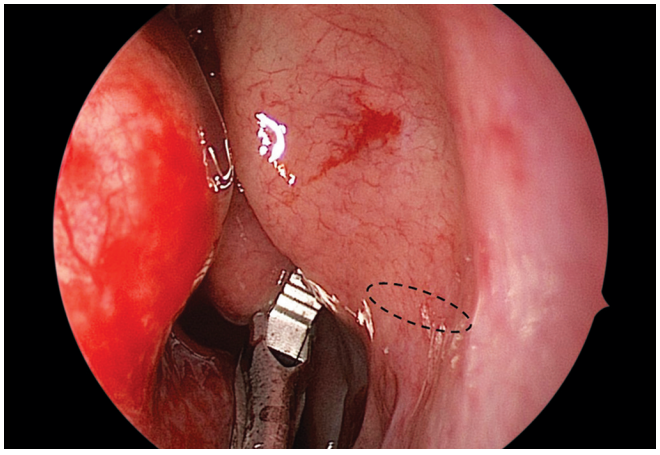


Fig. 9.8: Location of maxillary ostium behind the uncinate process (drawing).

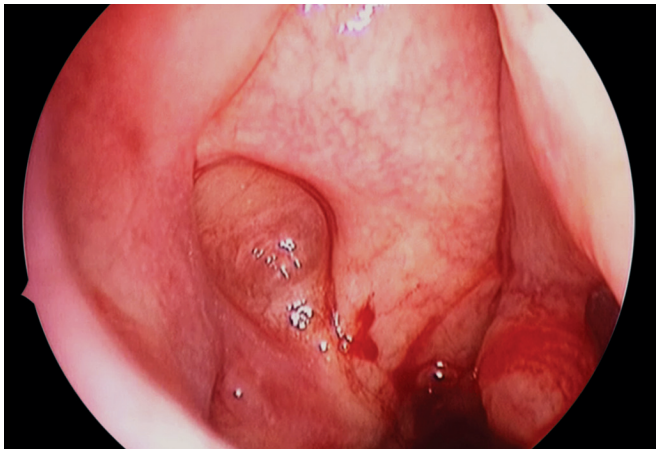


Fig. 9.9: Atelectatic uncinate. Seen often in the case of silent sinus syndrome, it may be helpful to first use the hook end of a frontal seeker to gently medialize the uncinate before removal.

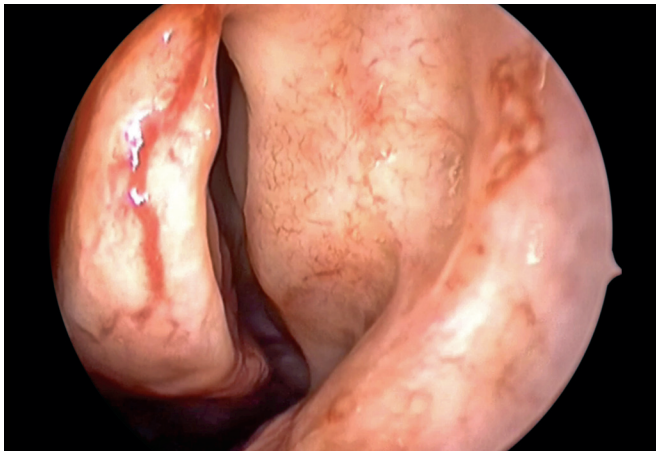


Fig. 9.10: Broad coronal uncinate. The uncinate exists in the coronal plane and use of backbiter may be difficult. Up-biting thru-cuts or Kerrison Rongeurs may work better depending on the actual angle.

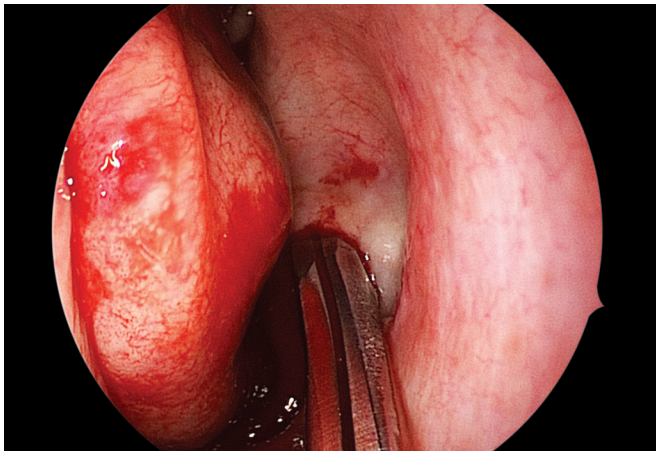
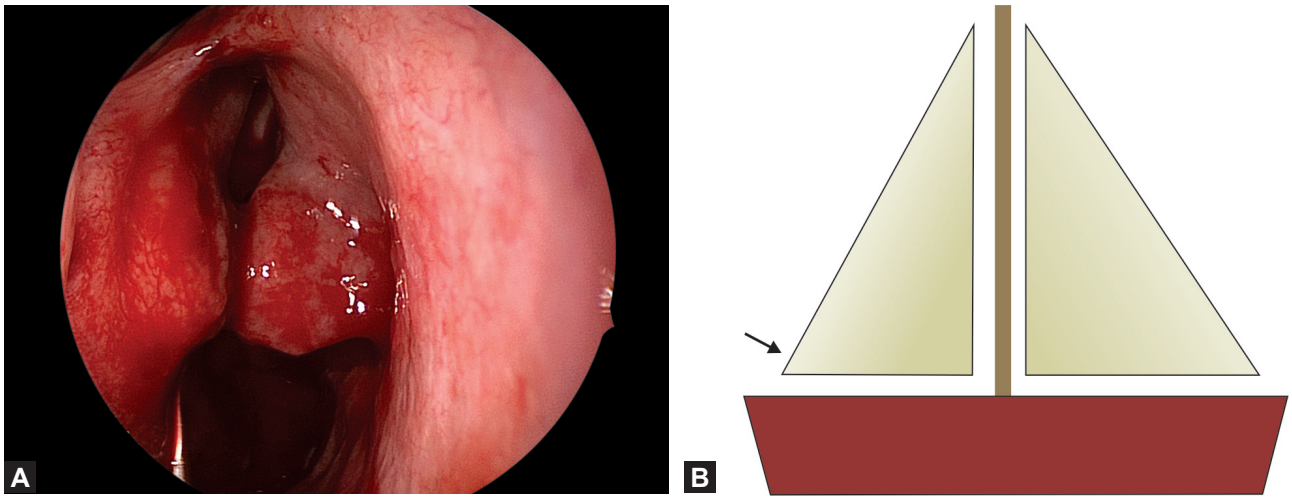
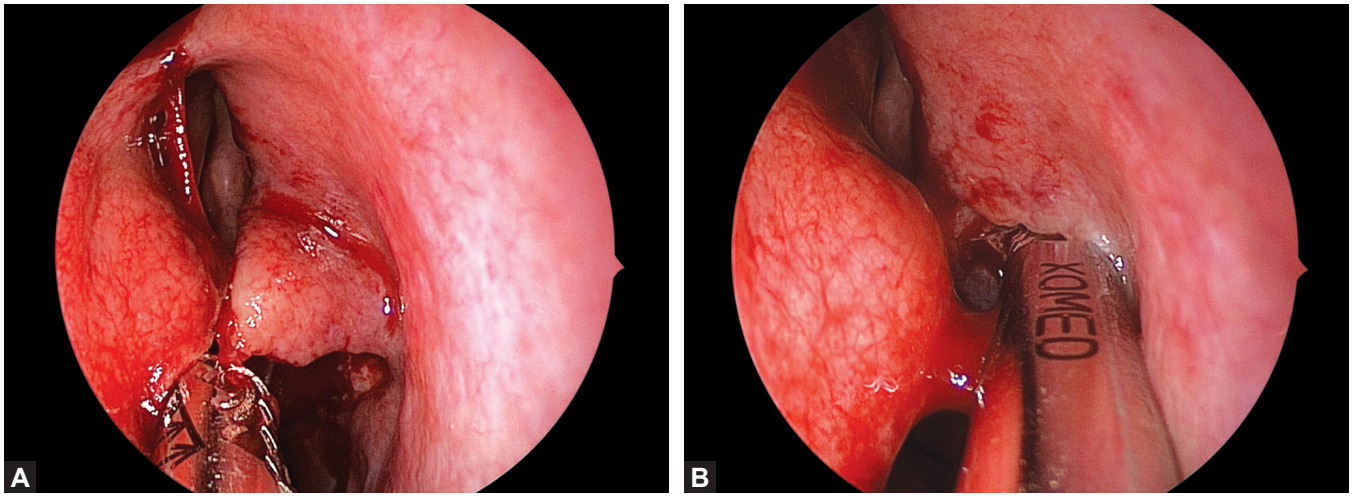


Fig. 9.11: Backbiter at anterior aspect of infundibulum. Note blanching where cutting tine is about to bite posterior to maxillary line.



Figs. 9.12A and B: The (A) incised uncinate process resembles an (B) aft sail. The arrow points to the clew of the aft sail.



Figs. 9.13A and B: Powered removal of the uncinate. (A) The "clew" of the uncinate is engaged first and the excision follows the; (B) lateral attachment of the uncinate superiorly.

seeker is placed into the infundibulum, directed superiorly and with medial traction along the anterior attachment of the uncinate, the uncinate is prolapsed such that its plane of projection is converted from its more typical sagittal to a coronal orientation. To a certain extent, it now resembles the aft sail of a boat with its mobile clew posteromedially (Figs. 9.12A and B).

- The superior portion of the uncinate is then removed. We employ either of two options for this:
  - Powered dissection: a closed, straight or gently angled (15°) microdebrider is introduced in to the middle meatus and directed towards the now inferior medial aspect of the uncinate. Starting at this "clew" the inferior portion is removed laterally and the microdebrider gradually turned superiorly such that it may skim the attachment to the lateral wall without producing undue injury to the mucosa of the lateral aspect of the infundibulum (Figs. 9.13A and B).
  - Nonpowered: Using an up-biting thru-cutting forcep, the uncinate is engaged at its anterolateral inferior aspect with the lateral cutting surface of the forcep against the lateral wall attachment (Fig. 9.14). Recognizing the crescentic shape of the uncinate, and with the operative wrist in radial-flexion, sequential bites are made superiorly until the uncinate transitions back into a primarily sagittal orientation. At this point, either rotation of

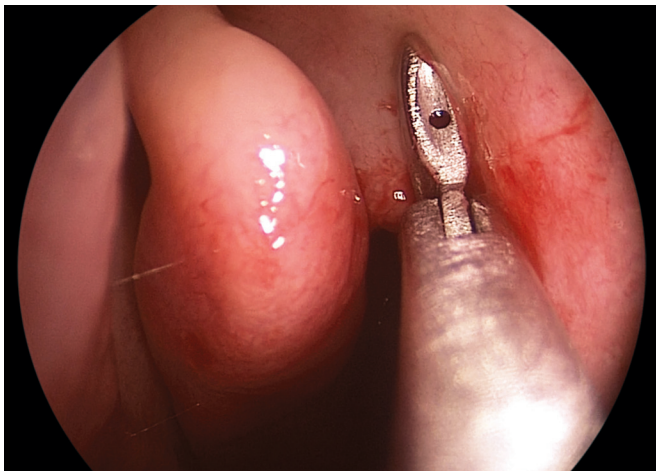


Fig. 9.14: Nonpowered removal of the uncinate. An up-biting thru-cutting forcep engages the uncinate attachment laterally and incision proceeds superiorly.

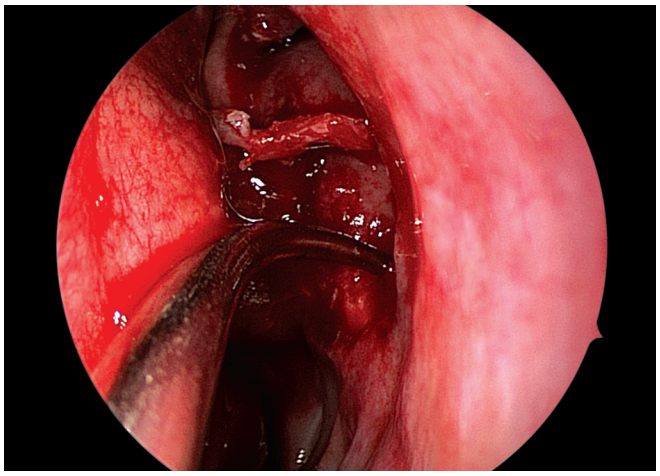


Fig. 9.15: Maxillary probe in normal location of ostium. Gently medialize the inferior aspect of the uncinate and dilate the ostium to make room for cutting instrument.

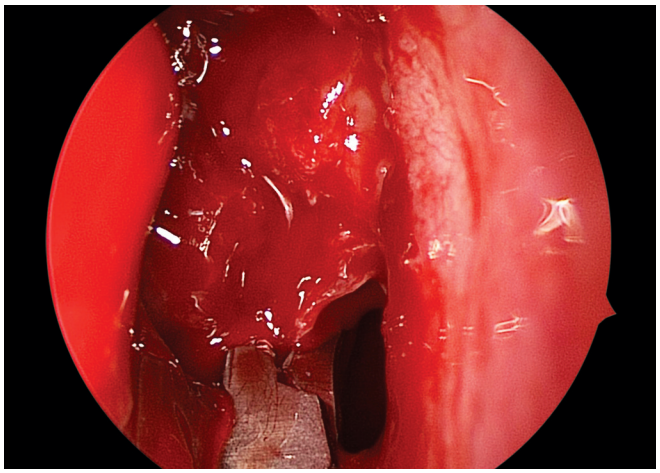


Fig. 9.16: Straight thru-cut extending antrostomy posteriorly. This cut is angled inferiorly and does not need to extend to the posterior maxillary wall.

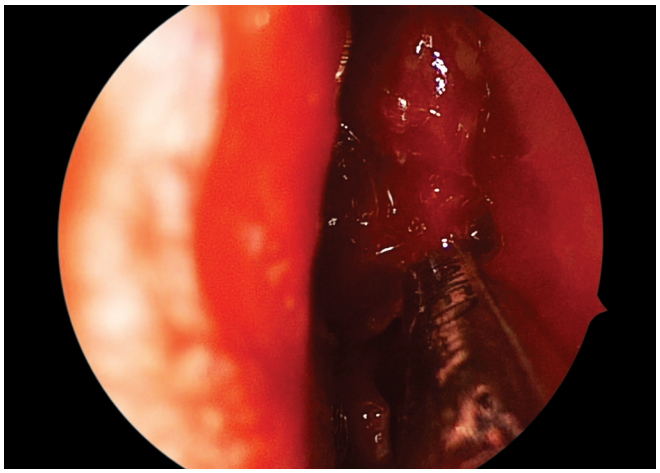


Fig. 9.17: Microdebrider is positioned to remove the "car door" of tissue.

the up-biting forcep medially or a straight cutting forcep is used to complete the excision. The area is then cleaned with microdebrider.

- The maxillary probe is again used to explore the infundibulum inferiorly, identify the maxillary ostium and then gently medialize the inferior portion of the uncinate to make room for cutting instruments (Fig. 9.15). An angled, 30° endoscope is often helpful at this point to fully visualize the ostium.
- A Stammberger down biting forcep is carefully inserted and the anterior aspect of the uncinate is excised in 2–3 cuts, advancing each subsequent cut slightly posteroinferiorly along the superior aspect of the inferior turbinate.
- A straight thru-cut is then inserted and the opening extended posteriorly to the desired size (Fig. 9.16). It is not often necessary to take the opening all the way to the posterior sinus wall, especially as branches of the sphenopalatine artery may be found in this area.
- This uncinate/medial maxillary wall complex can be thought of as a "car door" hinged posteriorly. After displacing the "door" medially, a microdebrider can then be used to remove it superiorly up to the orbital floor (Fig. 9.17) and subsequently cleanly trim the edges along the inferior turbinate, taking care to use the proximal cutting surface of the debrider opening in order to avoid abrasions along the turbinate.

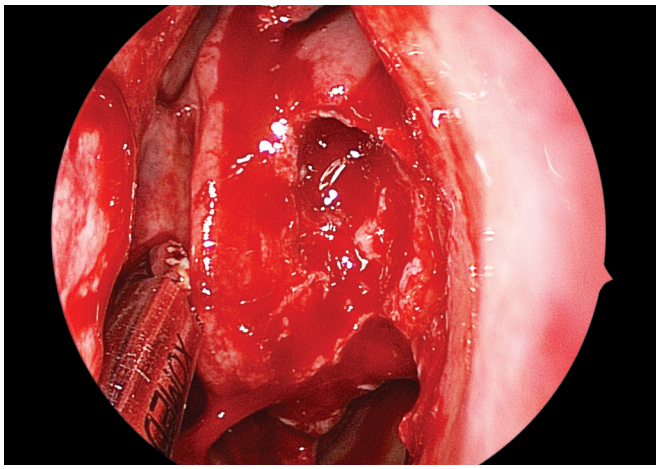


Fig. 9.18: Microdebrider positioned in the hiatus semilunaris superioris—The bulla is opened from medial to lateral.

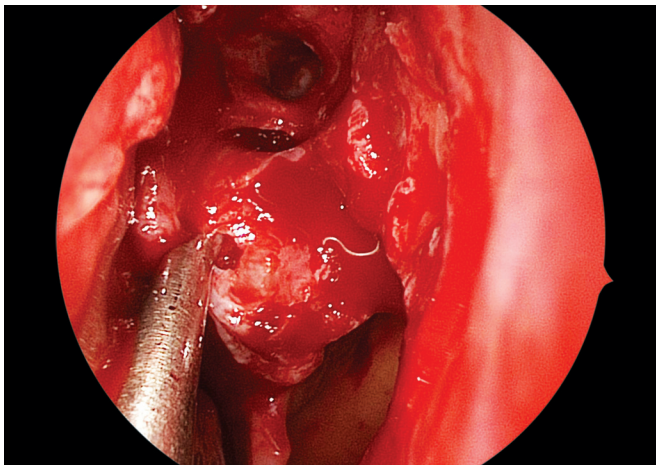


Fig. 9.19: Complex pneumatization of anterior ethmoid—Dissection has continued well posterior to the plane of the middle turbinate basal lamella without having breached it. An infrabullar cell is noted inferiorly (suction).

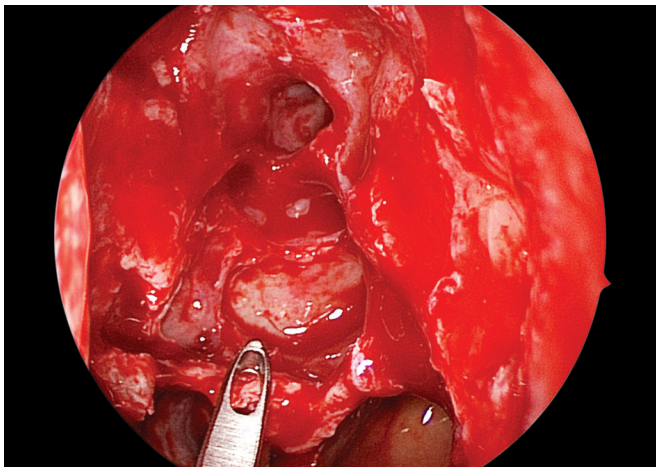


Fig. 9.20: Removal of inferior wall of infrabullar cell—The inferior portion of a bullar or infrabullar cell is often best removed with straight thru-cuts.

- Any intrasinus polyps are removed, biopsies or cultures taken, and the sinus then fully irrigated. An angled (40° or 60°) debrider can be helpful in removing any clearly mobile polyps within the sinus.

ETHMOIDECTOMY

Dissection of the ethmoid complex can be difficult because of its highly variable anatomy. Inspection of the CT scan preoperatively will help identify the presence of numerous suprabullar cells, variable pneumatization of the basal lamella of the middle turbinate resulting in apparent "middle-ethmoid" cells, and the slope of the transition of middle turbinate's coronal to axial component (seen best on sagittal imaging) which will better define the area to best transgress its basal lamella.

Anterior Ethmoidectomy

Steps:

- Following completion of the maxillary antrostomy, if performed, the middle meatus is thoroughly irrigated so that the next landmark (ethmoid bulla, ET2) can be identified.
- Starting medially in the hiatus semilunaris superioris (that space between the medial aspect of the bulla and the sagittal component of the middle turbinate), the bulla is opened. This can be completed with either a j-currette or microdebrider (Fig. 9.18).
- Once the space is opened, focus is paid to the anterior wall, which is opened from medial to lateral and from inferior to superior. Typically, a small ostium can be noted posteromedially and any tissue bridge spanning this should be removed.
- Otherwise complex pneumatization of the anterior ethmoid region may be present and dissection continues posteriorly to the area where the middle turbinate basal lamella would have originally suggested (Fig. 9.19).
- Identification of the orbital lamina is critical at this stage and bullar removal continues laterally until it is encountered. This can be facilitated laterally using a small 2-mm Kerrison Rongeur or mushroom punch.
- The inferior wall can be removed with straight thru cutting forceps (Fig. 9.20) or alternatively with the microdebrider aimed inferiorly. When using the

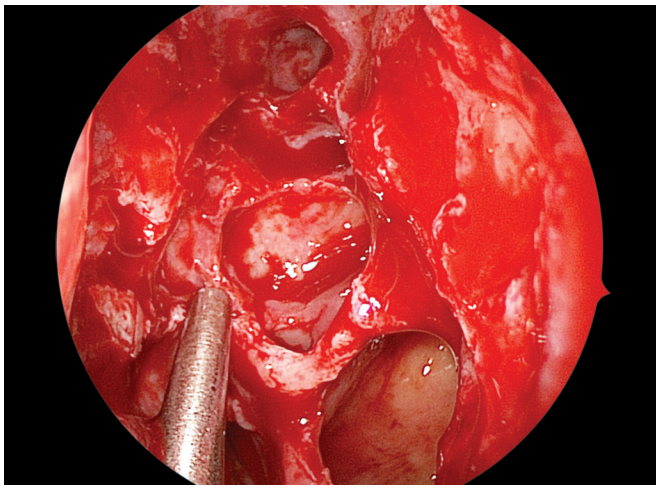


Fig. 9.21: Optimal site of middle turbinate basal lamella transgression. This is at the level of the roof of the maxillary sinus and approximately at the transition point between the coronal and axial segments of the middle turbinate.

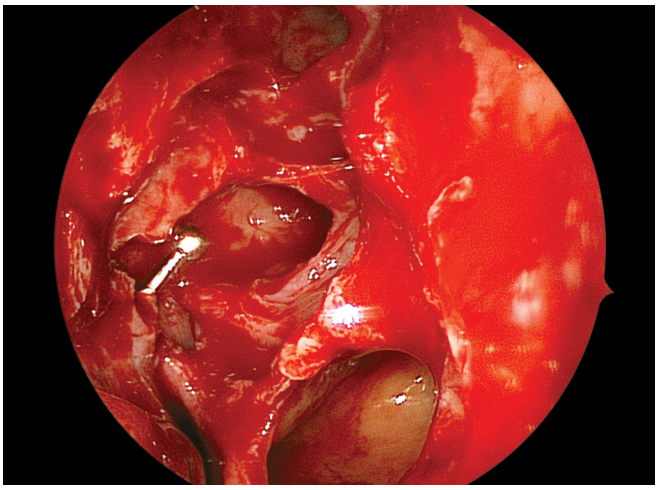


Fig. 9.22: Ball tip probe entering ethmoid complex through superior meatus.

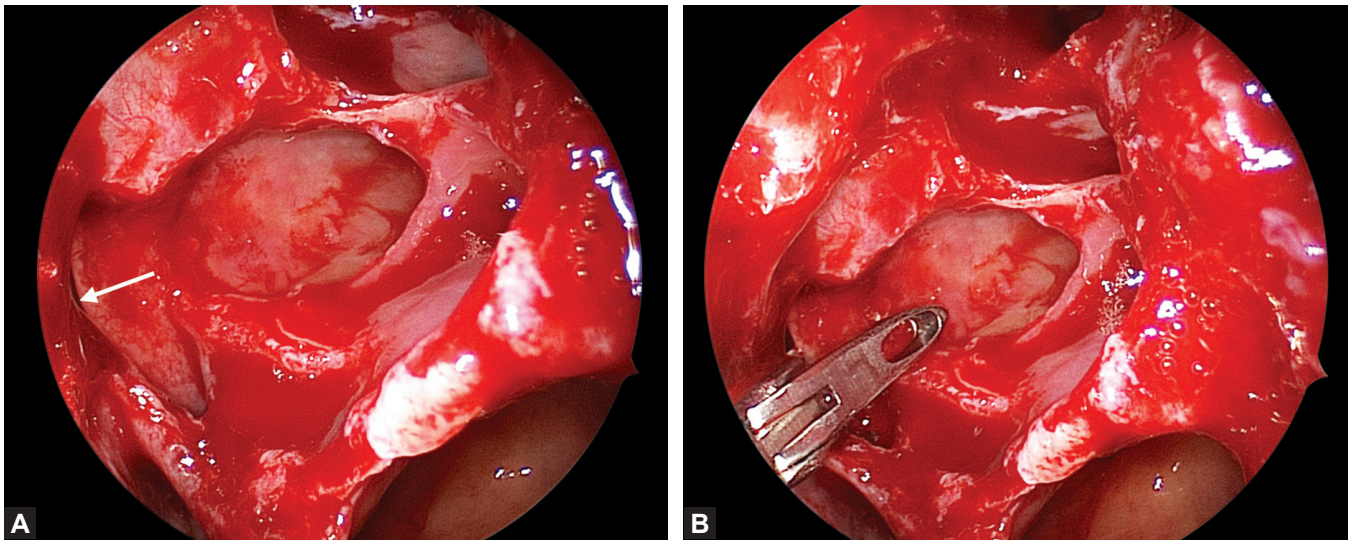
microdebrider to cut in an inferior direction, it is important to move the endoscope to a more medial or lateral position than the debrider itself so that visualization of the cutting surface is not obfuscated by absolute coaxial positioning.

- The removal of the superior aspect of the bullar face continues superiorly to a level below the cut surface of the uncinate. This is important regardless of whether a frontal exploration is to be performed. Maintaining different levels of dissection of these two structures will minimize postoperative scarring or later difficulty with the dissection if a frontal exploration is to be completed.

Posterior Ethmoidectomy

Steps:

- If a posterior ethmoidectomy is to be performed, the meatus is again copiously irrigated and any bleeding controlled either with warm irrigation or repeat vasoconstrictor-soaked packing.
- The third ET deriviative is identified, the basal lamella of the middle turbinate, and its slope is examined in relation to the roof of the maxillary sinus. The optimal point to transgress the turbinate is medially at a level consistent with the maxillary roof which is often where the coronal component of the turbinate transitions to an axial orientation (Fig. 9.21).
- The basal lamella is punctured either with curette or the microdebrider and the lamella opened up from medial to lateral following any cell tracts that can be identified.
- If the superior turbinate is not visible additional dissection medially at the level the basal lamella was transgressed should be performed. A ball tip probe can be slid past the middle turbinate medially and directed into the superior meatus to help identify this location if it is not readily apparent (Fig. 9.22).
- Once identified, and either through the middle meatus or the medial corridor, the inferior aspect of the superior turbinate is incised from anterior to posterior to the face of the sphenoid (Figs. 9.23A and B).
- Additional dissection of the inferior aspect of the posterior ethmoid complex can then be performed.
- If a sphenoidotomy is to be performed, follow the steps in the next section and establish the posterior skull base; otherwise confirm with image guidance or CT scan whether the posterior most ethmoid cell extends to the ethmoid roof. If it does not, consider a sphenoidotomy in order to safely establish this landmark.
- After completion of the sphenoidotomy, we find it easiest to dissect remaining ethmoid partitions with a reverse post 30° scope and angled microdebrider attachment. Be careful not to blind members of the operative team with the light cable while switching between endoscopes.
- Using a curved suction or angled curettes, the ethmoid roof is explored and the location of septations is noted. If the tissue is hypertrophied or polypoid in nature, a short curved 90° suction is most helpful in compressing this tissue and defining the anatomy (Fig. 9.24).



Figs. 9.23A and B: Superior turbinate being incised. (A) The edge of the superior turbinate can be seen (arrow) and the; (B) inferior aspect can be removed without concern for loss of smell as this area does not have olfactory neurons.

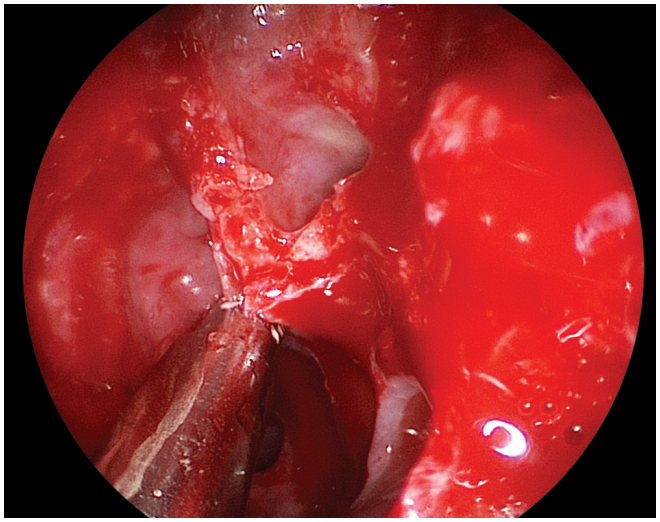


Fig. 9.24: Removal of ethmoid septations along the roof—This can be performed with microdebrider after first gentle fracturing with suction or curette or incising with thru-cutting forceps.

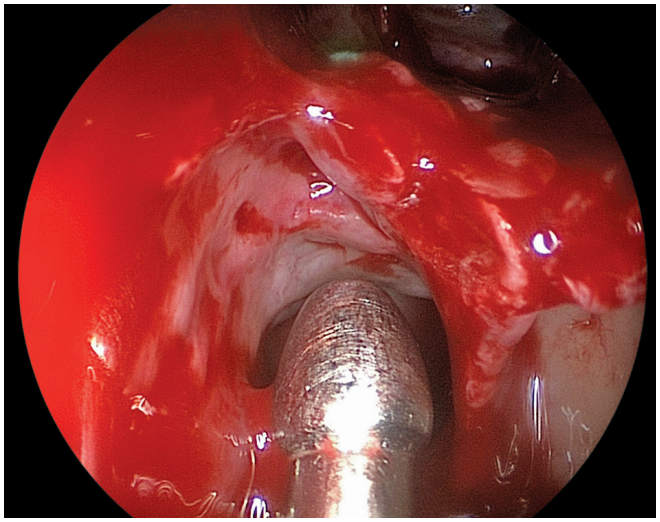


Fig. 9.25: Anterior ethmoid artery in mesentery of skull base. This prevents complete removal of septations to the ethmoid roof without placing the artery at risk and/or forcing the surgeon to clip and/or bipolar the artery.

- Up-biting thru-cutting forceps, giraffe forceps, or angled microdebrider are then used to take down the septations to the ethmoid roof. We progress from posterior to anterior. Take note of the location of the anterior ethmoid artery and whether it courses the skull base or below it in a mesentery. This is often just anterior to the attachment of the basal lamella of the middle turbinate to the ethmoid roof and dissection in this area should proceed cautiously (Fig. 9.25).

SPHENOIDOTOMY

After Initial AP Portion of Ethmoidectomy

Steps:

- After removal of the superior turbinate and dissection of the posterior ethmoid cells, the area is again copiously irrigated and bleeding controlled as necessary.

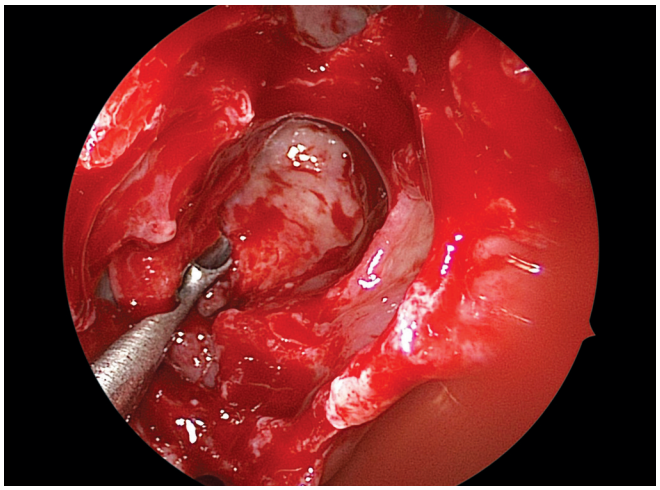


Fig. 9.26: Opening of sphenoid sinus—A cottle elevator or j-currette are placed within the ostium and the sphenoid face opened laterally.

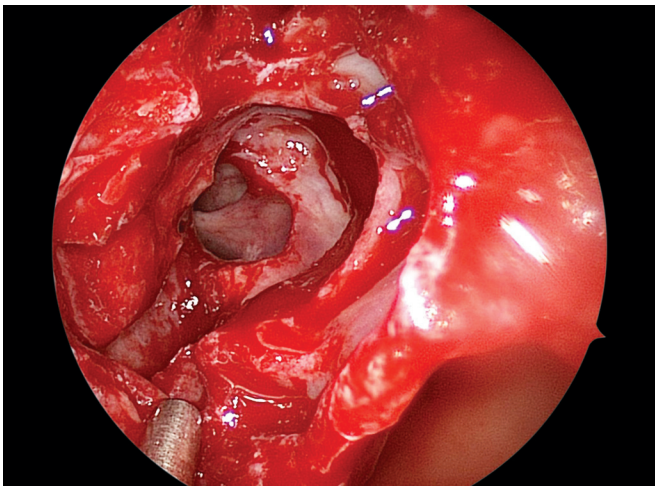


Fig. 9.27: Final sphenoid opening—The sphenoid has been extended maximally laterally and superiorly to minimize risk of postoperative scarring.

- A j-currette or Cottle elevator is then inserted into the sphenoid ostium and force is applied laterally and inferiorly to fracture the sphenoid face (Fig. 9.26).
- 2-mm Kerrison rongeurs can then be inserted and used to expand the opening laterally and superiorly. If the bone of the sphenoid face is rather thick and unable to be fractured as noted in Step 2, the Kerrison itself can be used initially. Inserting it upside-down will align the 45° tip perfectly with the orientation of the sphenoid ostium. Once through the ostium with the tip, it can then be rotated to face superolaterally and the ostium expanded as noted.
- The opening is cleaned with the microdebrider and further work with up-biting thru-cutting forceps expands the opening to the lamina and skull base working to create a square shaped opening which will minimize postoperative scarred closure (Fig. 9.27).
- Care is taken not to open the ostium inferiorly so as to not inadvertently disrupt the posterior septal artery. Additionally, we do not extend the opening inferomedially so as to preserve a small portion of intact mucosa of the ostium. It is felt that this will further reduce complete closure of the sphenoidotomy postoperatively.
- The ethmoidectomy is then completed if further work is necessary.

Isolated Sphenoid Disease; No Ethmoidectomy Completed

The reader is referred to Chapter 24: Steps 1–8.

FRONTAL SINUS EXPLORATION

Given the variability of the frontal sinus outflow tract, no one set of instructions can substitute for proper analysis of imaging and preoperative planning. As we learned in Chapter 3, the outflow tract is defined by the variations in the derivatives of the first and second ETs which exist, respectively, anterior and posterior to its course. Note must be made of the presence, or lack thereof, of Kuhn Type I, II, or III frontal cells as well as the existence and lateral extent of any suprabullar and/or, more specifically, supraorbital cells. Further, it is important to note the location of the uncinate attachment. If attaching laterally to the orbital lamina, as is present in 85% of patients, the outflow tract is directed medially. If it attaches medially or superiorly to the middle turbinate or ethmoid roof respectively then the tract is directed laterally. Superior attachment of the uncinate can also result in a secondary pneumatization in to the frontal bone medial to this site resulting in what has been termed an "intersinus septal cell." The net effect of the presence of this cell is an increased difficulty in obtaining an optimally sized opening as the septations between the frontal sinus and this cell can often be quite thick. In any event, repetitive cleaning of the dissection cavity with warm saline irrigations and reapplication of vasoconstrictor could not be more aggressively advocated as the dissection progresses.

Steps:

- A reverse post 30° or 45° endoscope is then utilized if it had not been in use already.

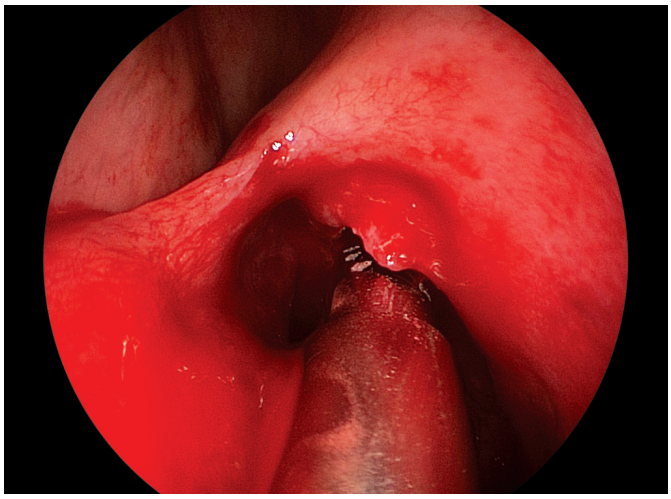
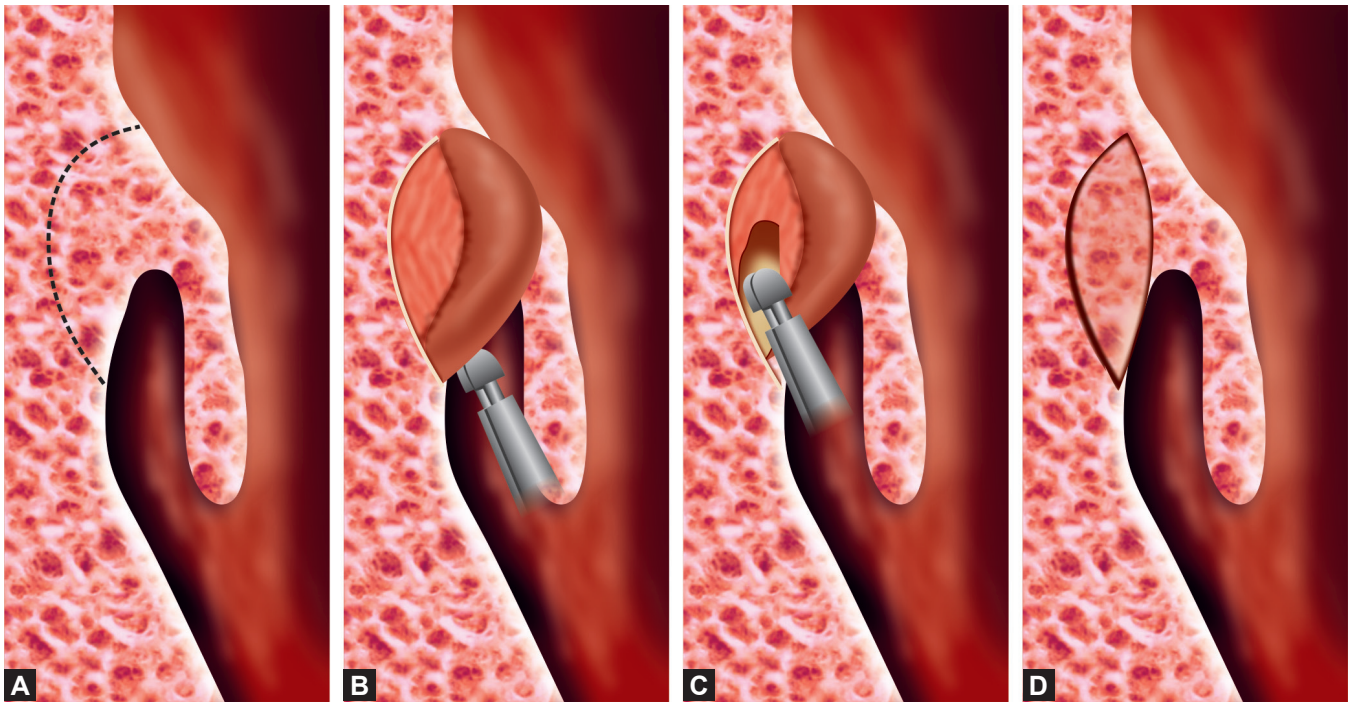


Fig. 9.28: Anterior opening of agger nasi cell. The bone is first cut with up-biting thru-cuts, standard or articulated Kerrison Rongeurs, and then the soft tissue cleaned with microdebrider.



Figs. 9.29A to D: Anterior opening of the agger nasi cell (alternate)—A tissue flap can be harvested from lateral to the axilla (A) before bone removal is performed (B and C) and then folded back down (D) to prevent scarring in this area.

- Any remaining uncinate tissue is resected as superiorly as possible to the undersurface of the agger nasi cell. This can be accomplished with angled microdebrider or, sometimes more quickly, with an angled punch such as a Frontal/Curved Kerrison or Hosemann punch.
- The floor of the agger nasi cell is punctured with curette or the microdebrider and opened anteriorly. Often this will involve removal of bone and mucosa just lateral to the attachment of the middle turbinate superiorly. Care must be taken to minimize trauma to the middle turbinate at this stage to prevent post-operative lateralization (Fig. 9.28). Mucosa from the caudal face of the agger may be harvested prior to the bone removal and folded posteriorly along the lateral aspect of the middle turbinate attachment after bone removal to prevent such "zippering" afterwards (Figs. 9.29A to D).
- The medial and posterior walls of the agger are then identified and are removed from inferior to superior

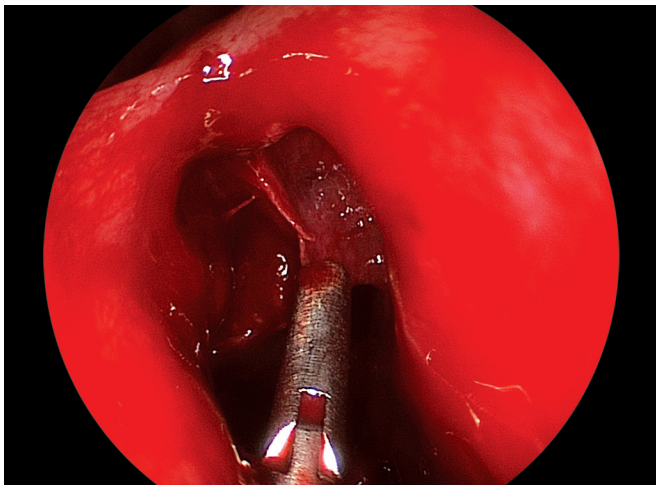


Fig. 9.30: Removal of posterior wall of the agger. With anterior agger wall removed, the posterior wall comes into view and can be removed, here with articulate Kerrison Rongeurs.

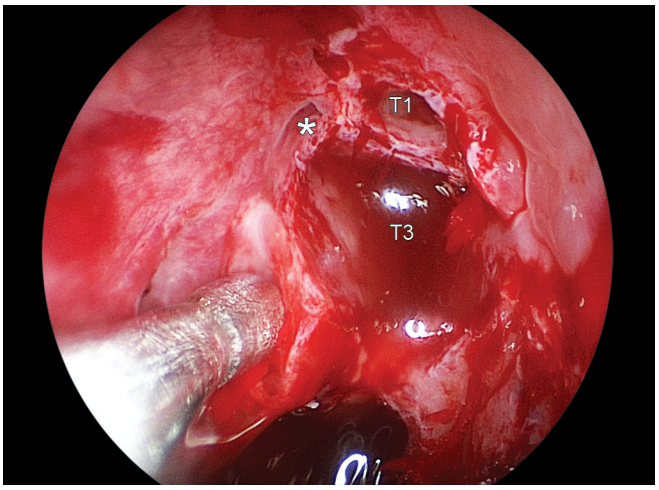


Fig. 9.31: Additional recess exploration—Removal of the superior portion of the agger nasi reveals opening to Type I cell laterally (T1), large opening to the type 3 cell inferiorly (T3) with the frontal outflow tract medially (asterisk).

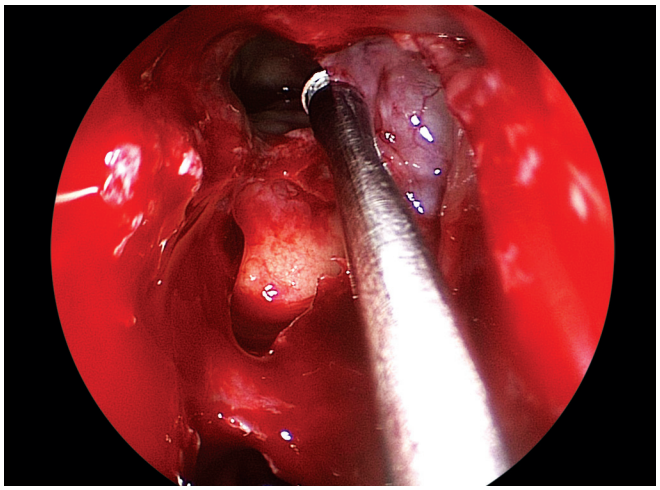


Fig. 9.32: Removal of the basal lamella of the ethmoid and roof of type 3 cell. Curved mushroom punch removing superior extension of ethmoid bulla lamella and roof of type 3 cell.

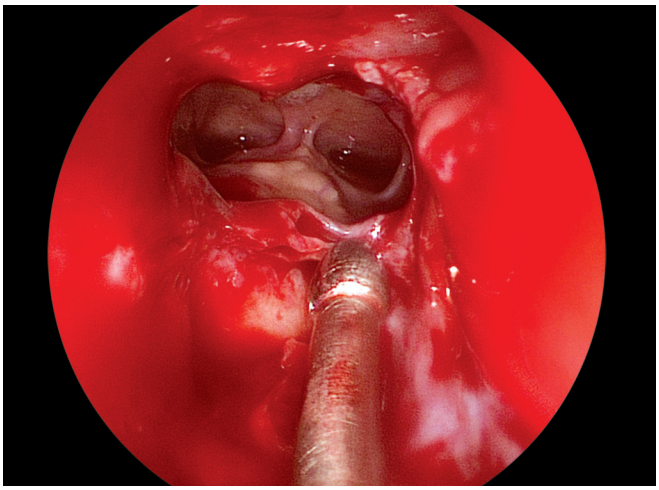


Fig. 9.33: Final opening of frontal sinus.

as well. This is often easiest with thru-cutting giraffe instruments followed by angled microdebriding to clean the edges (Fig. 9.30).

- With the agger cell removed inspection of the frontal recess continues. If this final "uncapping" opened the recess, the dissection is complete. Otherwise, as in this patient, dissection continues superiorly to open additional obstructing anatomy (Fig. 9.31).
- Removal of superior Kuhn Type Frontal cells is performed sequentially, using angled or articulating giraffe thru-cutting forceps.
- With removal of the medial and posterior walls of these cells the frontal sinus comes in to view and final removal of the basal lamella of the ethmoid (posterior aspect of outflow tract) and the roof of any remaining frontal cells is accomplished (Figs. 9.32 and 9.33).
- The frontal sinus is copiously irrigated to remove all mucous and/or infectious contents; this will further aid in hemostasis as well.
- A sheet of 0.20" silastic cut in a modified "liberty bell" configuration (Fig. 9.34) is then rolled and placed in the frontal opening with side grabbing giraffe

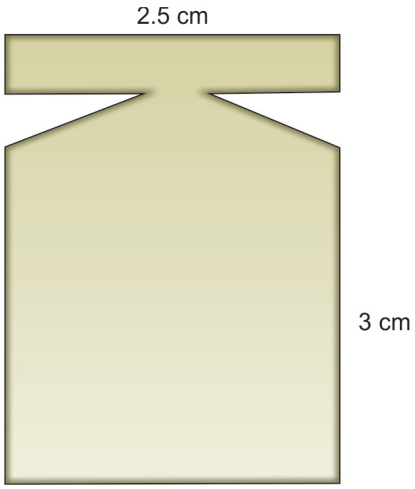


Fig. 9.34: Modified "Liberty bell" configuration of silastic sheet dressing.

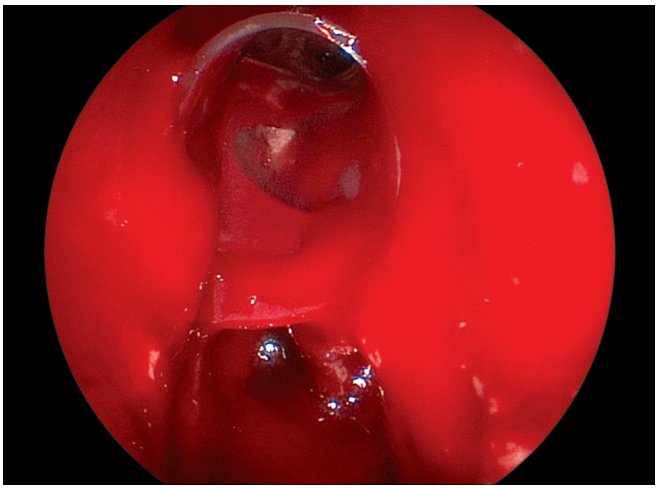


Fig. 9.35: Rolled silastic sheet dressing in place in frontal sinus opening.

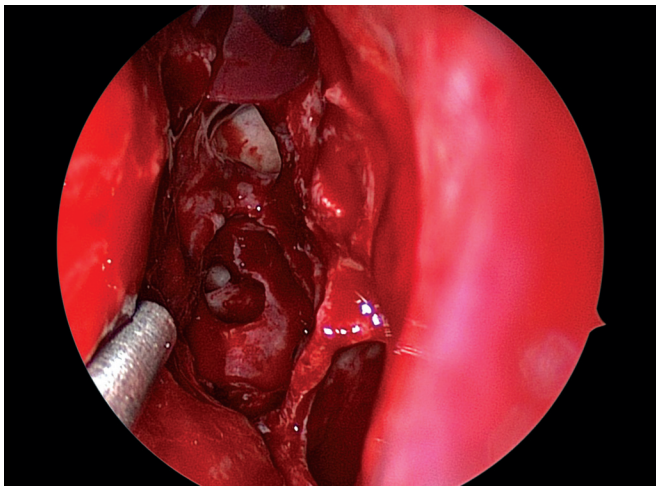


Fig. 9.36: Final common spheno-frontal-ethmoid cavity. The sphenoid sinus is seen in the distance with the maxillary opening laterally (right) and the rolled silastic visible in the frontal recess superiorly.

forceps (Fig. 9.35). This is only a temporary dressing to minimize fibrinous or sanguinous debris in this. It is to be removed at the first postoperative visit and greatly facilitates, more so eliminates, debridement in this area.

NASAL INSPECTION, CLEANING, AND DRESSING PLACEMENT

Steps:

- Following the completion of the operative plan, the nose is copiously irrigated with warm saline and the final cavity (Fig. 9.36) is inspected.
- Any residual sites of significant bleeding are identified. Consider expanding any mucosal or bone removal in areas of persistent oozing as a clean mucosal-to-mucosal coaptation will often solve the problem.
- Otherwise bipolar cautery is to be utilized as monopolar cautery will result in significant "collateral" damage.
- Any number of dressing materials is available to the surgeon at this point and a debate on their merits is beyond the scope of this chapter. We prefer to use a half-piece of a 4 cm Nasopore® dressing in each middle meatal cavity. It is positioned anteriorly between the head of the middle turbinate to help prevent lateralization or significant airflow through the ethmoid cavity so that healing can occur unabated by dried crusting.
- The nasal cavity, nasopharynx, oral cavity, and oropharynx are then suctioned and the patient allowed to emerge from anesthesia; it is preferable if in agreement with the anesthesiology colleagues for the patient to be extubated deep to prevent excessive coughing or straining due to irritation from the endotracheal tube or LMA on emergence.

CONCLUSIONS

Thorough sinus surgery requires careful preoperative planning and significant attention to the subtleties of instrument handling to prevent inadvertent trauma to the nasal cavity. No one surgery will be the most appropriate for all patients and the operative plan must be tailored to the anatomy and the disease. Attention to

the ET derivatives in order will maintain an orderly progression through the sinus cavities and when paired with identification of specific landmarks such as the maxillary roof, orbital lamina, and sphenoid sinus will optimize patient safety.

REFERENCES

1. Timperley D, Harvey RJ. Perioperativ and intraoperative techniques to improve surgical outcomes in skull base surgery. Otolaryngol Clin North Am. 2010;43:699-730.
2. Higgins TS, Hwang PH, Kingdom TT, et al. Systematic review of topical vasoconstrictors in endoscopic sinus surgery. Laryngoscope. 2011;121:422-32.
3. Schaefer SD, Li JC, Chan EK, et al. Combined anterior-to-posterior and posterior-to-anterior approach to paranasal sinus surgery: an update. Laryngoscope. 2006;116:509-13.
4. Chastain JB, Cooper MH, Sindwani R. The maxillary line: anatomic characterization and clinical utility of an important surgical landmark. Laryngoscope. 2005;115:990-2.
5. Getz AE, Hwang PH. Basal lamella relaxing incision improves endoscopic middle meatal access. Int Forum Allergy Rhinol. 2013;3:231-5.