“Outside-In” Frontal Drill-Out

SURGICAL TECHNIQUE PRESENTED BY RICHARD J. HARVEY, MD

Endoscopic View
Pre-Op
Post-Op
Introduction

Access to the frontal sinus is required in many situations. In chronic rhinosinusitis (CRS), patients often have chronic inflammation of the paranasal sinuses. The underlying process is chronic inflammation of the airway, and not that of simple obstruction of ostia. Wide frontal access is required for post-surgical topical drug delivery and removal of the thick, hypersecretory mucin that characterizes many CRS conditions.

In tumor surgery, most pathology that involves the skull base anterior to the anterior ethmoidal artery will necessitate a broad exposure of the frontal sinus. Postoperative surveillance of the sinus cavity is facilitated by an expanded frontal opening. Additionally, pathology in the frontal sinus or recess itself requires wide access. Examples include dural defects, mucoceles, and cases of prior trauma.

The limits of the endoscopic Lothrop or Draf 3 cavity are well-recognized. Laterally, it is the periosteum of the skin over the frontal process of the maxilla on both sides (Figures 1 and 2). Posteriorly, the first olfactory fascicle on each side demarcates the forward projection of the cribiform plate or olfactory groove (Figure 3). Anteriorly, the anterior table of the frontal sinus is the limit to which drilling should occur to maximize the sinusotomy (Figure 4).

Traditionally, the first step of the Draf 3 is to identify one frontal recess (usually the less challenging side) and proceed with bone removal. This often involves the use of angled endoscopes. However, finding the frontal recess can be difficult, as severity of disease and scarring is typical in patients considered for a Draf 3. This is particularly the case in endoscopic skull base surgery (ESBS), where initial identification of the frontal recess is often impractical when a tumor occupies this area.

The “Outside-In” Approach

The “outside-in” Draf 3 is an approach that avoids initial dissection in the frontal recess, where the anatomy is the tightest and most challenging. Bone removal is performed below the frontal sinus floor to the periosteum of the skin to develop wide exposure. The dissection limits are defined early, much like the approach to modified radical mastoidectomy in otology.

Avoiding the frontal recess and directly entering the floor of the frontal sinus is not a new concept— it has been suggested as a maneuver when the frontal recess is not identified. However, recognizing the periosteum and first olfactory neuron at the beginning of this approach orients the surgeon early to the limits of surgical dissection. This in turn allows a quick and safe removal of bone, evolving a procedure from one that was considered a significant undertaking to a fast and efficient technique for managing the frontal sinus.
Step 1:
A 0° endoscope and 5 mm, 15° Diamond Bur (1885076HSE) are used throughout the entire case.

The patient’s endotracheal tube is placed toward the bottom right of the oral cavity. A flexible extension tube is used to ensure that any anesthetic filter equipment is away from the chin and neck area.

Prep the patient both topically with 1% ropivacaine and 1:2,000 adrenaline (0.5 x 3” and via injection with 1% ropivacaine and 1:100,000 adrenaline. Injection points include the middle turbinate, lateral wall near the axilla, floor of the frontal sinus, and septum near the anterior ethmoid artery entry point/swell body.

The patient’s head is extended 30-40°, which often requires either removing the head ring or a shoulder roll. The surgical bed is still placed at 15-20° in a reverse Trendelenburg position during a total intravenous anesthesia (TIVA)/remifentanil-based anesthetic. Note: If image guidance will be used, then the registration should be performed after the head is in this position (all image guidance systems), and before placing the patient in reverse Trendelenburg position (for optical image guidance systems).

Step 2:
A minimum anterior ethmoidectomy is performed to identify the medial orbital wall. However, Draf 3 procedures are most commonly performed when a full sphenioethmoidectomy has already occurred (Figure 5). This defines both the medial orbital wall and skull base posteriorly.

Step 3:
Remove the mucosa overlying the naso-frontal beak, frontal sinus floor, and area of the septum corresponding to the septal window. This is performed as a single flap, subperiosteal dissection on each side.

Superoanterior, the incision begins at a point underneath the frontal sinus, but in line with the outer cortical rim of the anterior table (Figures 6 and 8). Laterally, the incision is placed in line with the medial orbital wall (Figure 7).
Step 3 (continued):

This will ensure that the full width of the ethmoid is included in the exposure. In general, the anterior inferior limit of the medial or septal incision is 5mm anterior to the lateral incision (so they are staggered to prevent adhesion), and level with the upper one-third and lower two-thirds of the middle turbinate (Figure 9). However, this is flexible to accommodate a large septal swell body or high deviation. The incision is then taken posterior to approximately the level of:

1. The middle turbinate, or
2. The beginning of the middle meatus, or
3. The anterior limit of antrostomy or ethmoid cavity (whichever approximate landmark exists).

Needle-tip diathermy (Megadyne 0016AM) is used to make the incisions. A full-thickness incision is made in the anteroinferior location, so that the contralateral mucosal flap can be removed with similar proportions (Figures 10 and 11).

A Cottle elevator is used to raise the mucosa (Figure 12). The dissection begins in the apex, then the septum, and finally the lateral wall. The entire flap is folded back into the olfactory cleft. A small emissary vein/nerve (Figure 13) is usually seen prior to the first olfactory fascicle (Figure 14). This vein is often running in a lateral direction to distinguish it from the olfactory fascicle. The first fascicle or neuron is tightly adherent to the skull base and dissection ‘through it’ is very difficult in careful hands, due to a sleeve of periosteum that accompanies it into the skull base (Figure 15).
Step 4:
The exposed septum is mostly bone, but does include the trabecular bone-cartilage junction (swell body) area. Removal is performed with a 2mm, 40° Kerrison rongeur. The rongeur is placed in the anterior inferior opening and taken directly superiorly to the anterior limit on the floor of the frontal sinus (Figures 16 and 17). Heavy Mayo scissors are then used to make a superior and inferior cut in the septum (Figure 18). Additional intermediate cuts can be made and the septal fragments removed (Figure 19). A crest of bone will remain on the floor of the frontal sinus.

Once both mucosal flaps (that were raised back to the first olfactory fascicle) are exposed, the redundant mucosa is removed with a microdebrider (StraightShot® M4) (Figure 20). Harvesting for a free mucosal graft is possible, but unnecessary and time-consuming.

Step 5:
If necessary, use bipolar cautery and trim the mucosal edges prior to any drilling. The 5mm, 15° Rough Diamond Bur (Medtronic 1885076HSE) is used for drilling. Begin drilling by removing the midline crest of septal bone that remains underneath the frontal sinus (Figure 21). The bone removal then proceeds to the lateral wall where the periosteum is identified superiorly (Figure 22). The periosteum is often distinguished as a white barrier compared to the yellow bone. This is performed bilaterally.

The full limits of the future sinusotomy are now defined, with the periosteum marking the lateral limits and the olfactory fascicle defining the posterior limit. It is not possible to enter the skull base unintentionally, unless drilling occurs on or near the first olfactory neuron. The frontal recess and sinus itself are between the operator and the skull base at this point (Figures 23 and 24).
Step 6:
Using the now-defined limits, the bone is drilled in a single ‘horseshoe’ movement between those anatomical structures. The cavity is intentionally kept smooth to allow for easy drilling, fast removal, and to avoid jumping of the bur (Figure 25). Drilling at this stage is similar to a canalplasty and bone is removed between the set limits. Surgeons who are unfamiliar with this technique may feel uneasy drilling in this block of bone because dissection does not follow sinus pneumatization (Figure 25). Using an image guidance system can provide reassurance as to the extent of bone removal, but is not required when confidence in the predefined landmarks is obtained. The frontal sinus floor will often appear in the midline within the first minute of drilling, and surgeons should take care NOT to enter this space (Figure 26). Doing so will only expose underprepared, bleeding mucosa to the operative field. The bone removal should approximate the shape of the naso-frontal beak from ‘within’.

Step 7:
Once the remaining bone shelf is very thin, the 2mm, 40º Kerrison rongeur is used to connect the frontal recess up to the surgical cavity (Figures 27 and 28). Any remaining frontal recess partitions are removed. The intersinus septum is removed. The orbital wall is followed to discover the orbital roof, and this ‘squares off’ the cavity (Figure 29). Under careful visualization, the bone of the posterior septum is drilled back to the origins of the first olfactory neuron. This “T” segment of bone is important to remove (Figure 30).

A precut Draf 3 Silastic® template is placed in the opening. No suturing is required, and the template is removed 3-4 weeks postoperatively.
Conclusion

The ‘outside-in’ technique describes a surgical approach that relies upon locating fixed anatomical landmarks. Such identification quickly orients the surgeon, avoids injury to critical structures, and ensures that a maximal opening is created to the frontal sinus. With the limits defined early in the operation, bone removal can be performed in a fast and efficient manner. This makes the Draf 3 an easy addition to endoscopic sinus surgery when wide access to the frontal sinus is required.
