



The Draf III procedure: A review of indications and techniques

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Abstract

The Draf III procedure involves the creation of a common frontal sinus cavity. The most common indication for the Draf III procedure is chronic rhinosinusitis of the frontal sinuses despite the failure of more conservative interventions such as bilateral Draf IIa procedures. Primary Draf III may be indicated in patients with a high risk of failures such as those with severe polyposis and those with a frontal sinus opening less than 4 mm on computed tomography imaging. Other indications for the Draf III include access for tumor removal and repair of traumatic fractures of the frontal sinus. The “inside-out” Draf III procedure is the standard approach when the frontal recess anterior–posterior diameter is wide enough for instrument access, usually larger than 4–5 mm. The “outside-in” Draf III procedure can be done when the frontal recess is too narrow to safely accommodate instruments. Regular follow-up with debridement should be done to prevent neo-ostium stenosis.

KEYWORDS

Draf III, endoscopic modified Lothrop procedure, endoscopic sinus surgery, frontal sinus surgery

INTRODUCTION

Endoscopic frontal sinus surgery has historically been challenging due to difficult visualization of the frontal recess, specialized instrumentation, nuanced techniques, and limited postoperative topical medical delivery.¹ As a result, high failure rates had been the norm, with persistent frontal sinusitis symptoms estimated in 2%–11% at short-term follow-up,² and long-term failure estimated at 15%–20%.^{3,4} Often, the cause of failure is due to inadequate resection of frontoethmoidal cells and/or the agger nasi cell at the superior portion of the uncinate process. However, even if the frontal recess is adequately opened, failure can occur due to mucosal inflammation, scarring, and recurrent polyposis that narrows and/or closes off the recently opened frontal recess.⁴ To address these challenges, in 1991 Wolfgang Draf, MD, first described a series of extended procedures to sequentially open the frontal sinus outflow tract more widely. The most extensive of these procedures was known as the Draf III and involved the

creation of a common frontal sinus cavity.⁵ In 1995, Charles Gross, MD, further defined the Draf III as it is currently known, the endoscopic modified Lothrop procedure.⁶

ANATOMIC CONSIDERATIONS

The frontal recess is defined by four consistent boundaries: the ethmoid bulla posteriorly, the agger nasi cell anteriorly, the lamina papyracea laterally, and the cribriform plate of the skull base with the middle turbinate medially. The frontal sinus outflow tract can vary depending on the attachment of the uncinate process. In the majority of cases, the uncinate process attaches to the lamina papyracea and the frontal sinus drains directly into the middle meatus (Figure 1). In the remaining cases, the uncinate process attaches either to the roof of the ethmoid or the middle turbinate and the frontal sinus drains into the ethmoid infundibulum.⁷

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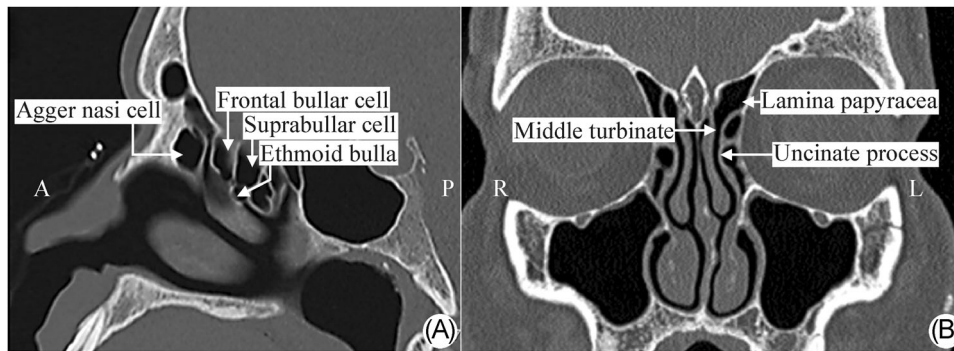


FIGURE 1 Sagittal (A) and coronal (B) images depicting the frontal sinus outflow tract and its boundaries. Anteriorly, demarcated by the agger nasi cell, posteriorly demarcated by the ethmoid bulla and bullar cells, laterally by the lamina papyracea, and medially by the middle turbinate. In this patient, the uncinate process can be seen inserting into the lamina papyracea, facilitating drainage of the frontal sinus into the middle meatus

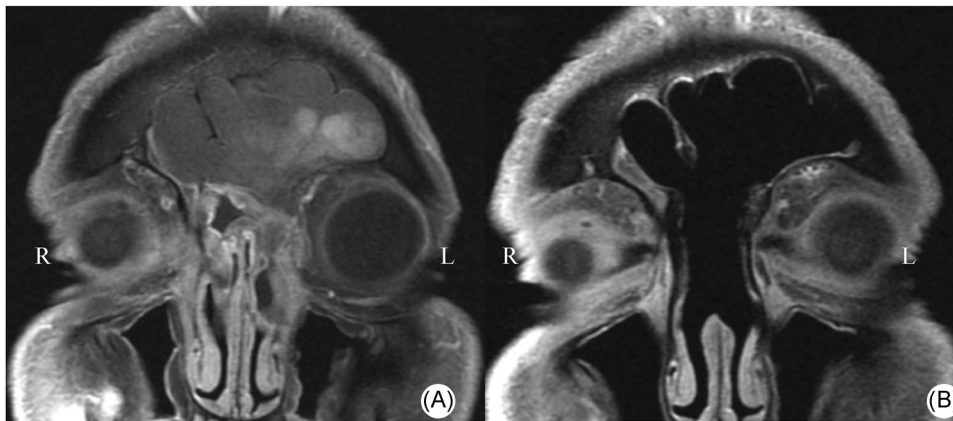


FIGURE 2 Preoperative (A) magnetic resonance imaging (MRI) of a patient with significant frontal sinus obstruction, demonstrating significant frontal sinus disease. Postoperative (B) MRI of the same patient after the Draf III procedure. Note the removal of intersinus septum and superior nasal septum creating a large common cavity for sinus drainage (Property of Columbia University Division of Rhinology)

The least extensive of the Draf procedures, the Draf I opens the frontal recess within the defined boundaries by removing the ethmoid bulla and any other ethmoidal cells directly obstructing the outflow tract. The Draf IIa expands the frontal recess by removing the agger nasi cell and ethmoid bulla completely as well as removing any partitions lateral to the edge of the middle turbinate. The Draf IIb extends the recess medially to the nasal and intersinus septum, often by using a drill or other frontal sinus instruments. The Draf III is the most extensive and involves bilateral Draf IIb procedures combined with a superior septectomy and removal of the intersinus septation to create a common frontal sinus cavity (Figure 2).^{5,6} The Draf III limits of resection are the external periosteum of the frontal process of the maxilla anteriorly, the lamina papyracea of the orbit laterally, and the first olfactory fibers posteriorly.⁸

INDICATIONS

The mainstay of treatment for chronic rhinosinusitis (CRS) is topical medical therapy delivered to the sinus mucosa.⁹ One primary aim of endoscopic sinus surgery (ESS) is to open the sinuses, allowing

delivery to occur more efficiently and effectively. The frontal sinus presents particular challenges because of its angulated superior location and relatively small confines that are prone to scarring and postoperative obstruction.⁷ Most surgeons will pursue a Draf I or Draf IIa procedure as the first-line management of uncomplicated CRS within the frontal sinus. Nevertheless, even with a Draf IIa procedure, restenosis is common and occurs in 10%–30% of patients.¹⁰ The risk of a Draf IIa failure due to restenosis is highest if the final frontal sinus opening is less than 4–5 mm wide, and the risk increases with decreasing the diameter of the final opening.^{10–12} When CRS persists despite more conservative interventions, such as bilateral Draf IIa procedures, a Draf III procedure is indicated.⁸ A maximally opened frontal sinus with the creation of a neo-ostium is an effective way to ensure topical medical delivery reaches the frontal sinus mucosa in cases of recalcitrant disease. A recent systematic review notes that 79% of all Draf III procedures are performed for CRS and the remainder for neoplastic or skull base disorders.¹³ The general indications for a Draf III frontal sinusotomy are detailed below and described in Table 1.

There are a number of pathologic conditions and anatomical variations to sinus anatomy that may warrant consideration of a Draf

TABLE 1 Indications for the Draf III procedure

Primary intervention
Severe frontal sinus disease in the following diagnostic conditions
Aspirin exacerbated respiratory disease
Cystic fibrosis
Ciliary dyskinesia
Frontal sinus opening of less than 4 mm on imaging
Management of benign frontal sinus masses
Mucocele
Inverted papilloma
Osteoma
Fibrous dysplasia
Encephalocele
Ossifying fibroma
Management of malignant lesions/masses of the frontal sinus
Melanoma
Adenocarcinoma
Squamous cell carcinoma
Sinonasal undifferentiated carcinoma
Sinonasal neuroendocrine carcinoma
Esthesioneuroblastoma
Trauma to frontal sinus outflow tract
Secondary Intervention
Recalcitrant or recurrent frontal chronic rhinosinusitis despite previous Draf IIa or Draf IIb procedures

III as the primary surgical management of the frontal sinuses. The Draf III procedure may be considered as the primary surgery for frontal sinus disease in patients with severe polyposis from diseases such as aspirin-exacerbated respiratory disease,¹⁴ cystic fibrosis,¹⁵ or ciliary dyskinesia and its associated diseases.⁸ These diseases may ultimately require the patient to undergo a Draf III, so it may be reasonable to pursue a Draf III initially when anatomy is least disrupted if the surgeon feels comfortable with the procedure and the patient elects for the more definitive surgical intervention. Even with Draf III in these high-risk conditions, restenosis is a common postoperative complication.¹⁵ Another possible indication for a primary Draf III is a frontal sinus opening less than 4 mm on computed tomography (CT) imaging, as these patients are at high risk of failure following a Draf IIa.

The Draf III is also indicated in the management of benign and malignant masses and tumors. A frontal mucocele was the indication for 10.5% of all Draf III procedures in a recent systematic review, making it the most common non-CRS indication.¹³ The vast majority of these mucoceles are caused by trauma or previous frontal sinus surgery. Other common benign tumors that can be successfully managed via a Draf III approach include osteomas, encephaloceles, inverted papillomas, fibrous dysplasia, and ossifying fibroma.^{13,16} The expansion of the Draf III for

tumors has expanded significantly in the last two decades, as comfort and expertise with endoscopic procedures have improved and technology advanced. Specifically, advancements in image guidance technology, comfort with and routine employment of 30° and 70° endoscopes, improvements with frontal sinus instrumentation, and high-powered angled burrs (up to 70° with 30,000–60,000 revolutions per minute (RPM)) has made the Draf III a more viable choice for tumor resection compared with an open approach.¹⁷

Finally, trauma remains a rare indication for the Draf III.¹³ Fractures of the frontal sinus can lead to a plethora of complications, including cosmetic defects due to anterior table injuries, cerebrospinal fluid leaks due to posterior table injuries, and long-term sequelae like mucoceles due to obstruction of the frontal recess. Traditionally, to resolve these complications, frontal sinus fractures have required open procedures, such as sinus obliterations or cranializations.¹⁸ However, shifts toward endoscopic management have been occurring for quite some time, and have recently been well-documented by researchers at the University of Alabama-Birmingham.¹⁹ Grayson et al.¹⁹ notes that the Draf IIb is the main workhorse for accessing the frontal sinus, regardless of the location of the fracture or indication for surgical intervention. However, in approximately 17% of his cases, he needed to expand to a Draf III intraoperatively for purposes of visualization and access to the lateral frontal sinus.¹⁹

There are few contraindications for the Draf III. A general contraindication is any active airway inflammatory disease requiring systemic steroids, such as autoimmune exacerbations in Wegner's granulomatosis or chronic obstructive pulmonary disease. Generally, these patients are already receiving adequate treatment systemically and do not benefit more from the increased topical steroid delivery provided by a Draf III; the procedure should not be done until topical medications are their primary treatment.¹⁴ A contraindication for a Draf III is a posterior table to nasofrontal beak skin distance of less than 5 mm, as this makes the surgery impossible without violating the skin.¹⁴

PREOPERATIVE EVALUATION

A complete history and physical examination should be performed before surgery and should include an endoscopic evaluation of the patient's current disease burden and anatomical considerations. Specific attention should be paid to the level of disease outside the frontal sinus, which may necessitate surgery beyond the Draf III. The need for a septoplasty based on septal deviation should be evaluated with the expectation that a superior septectomy will be performed.

A fine cut CT scan of the sinuses, adequate for image guidance, should be done before surgery. Careful preoperative evaluation of the CT should focus on the following: size and shape of the frontal sinus, the orientation of the intersinus septum, the presence of supra agger frontal cells, suprabullar frontal cells, supraorbital ethmoid cells, and/or frontal septal cells,⁷ the thickness of the nasofrontal beak, the distance of the posterior table to the nasofrontal beak skin (which must be >5 mm), the location of the olfactory fossa as the lowest point of the anterior cranial fossa, the location of the anterior ethmoid artery in relation to the skull

base and frontoethmoidal cells, the extent of septal cartilage deviation, and the presence of areas of dehiscence of the lamina papyracea, anterior ethmoid artery, or the posterior table.¹⁴ Critical review of these factors is necessary to ensure safe and effective surgery.

Proper instrumentation is key to a successful surgery, as many instruments are unique to the frontal sinus and not routinely used for the lower sinuses. The 0°, 30°, 45°, and 70° endoscopes are helpful to properly visualize not only the frontal sinus recess superiorly but also the superior septum and contralateral frontal sinus from the viewpoint of the other nostril. In addition, a “cobra” (link chain sheath 70° upturned backward cutting frontal sinus punch), and Storz Hosemann Frontal Sinus Recess Punch can remove bony partitions and fragments when combined with an angled microdebrider blade. Finally, a 15° and/or 70° self-irrigating drill with 30K–70K RPM combined with an assortment of cutting and diamond burrs ranging from 3 to 5 mm is helpful in removing the thick bone of the frontal sinus floor.

THE INSIDE-OUT DRAF III PROCEDURE

The “inside-out” Draf III procedure is the standard approach when the frontal recess anterior–posterior diameter is wide enough for instrument access, usually larger than 4–5 mm. This is generally

performed following completion of a full ESS including maxillary antrostomies, complete ethmoidectomies, and sphenoidotomies. Using a combination of 0°, 30°, and 70° endoscopes, the complete removal of the uncinat process is performed, including its superior portion connected to the posterior portion of the lacrimal bone. A 2-mm Kerrison punch can then be used to remove the anterior face and medial edge of the agger nasi cell above the uncinat process. At this point, the ethmoid skull base has been skeletonized and the medial orbital wall identified.

Next, the frontal recess is identified and widened with a combination of frontal probes, curved suctions, and angled instruments (Figure 3). If the face of the ethmoid bulla is still intact, it can serve as a useful posterior landmark to help identify the frontal recess.⁸ Care must be taken not to strip the frontal sinus mucosa during this process as this can lead to scarring.²⁰

After the adequate opening of the frontal recess is achieved bilaterally, an approximately 2 cm septal window is then made caudally to dorsally just below the floor of the frontal sinus and extended inferiorly to approximately half the vertical length of the remaining middle turbinate.²¹ The window extends dorsally to the connection of the septum to the frontal sinus. This allows the surgeon to connect the two frontal sinuses, moving anteriorly to the frontal process. The septal window does not extend anteriorly past the nasal bone, to avoid a saddle nose deformity from loss of dorsal

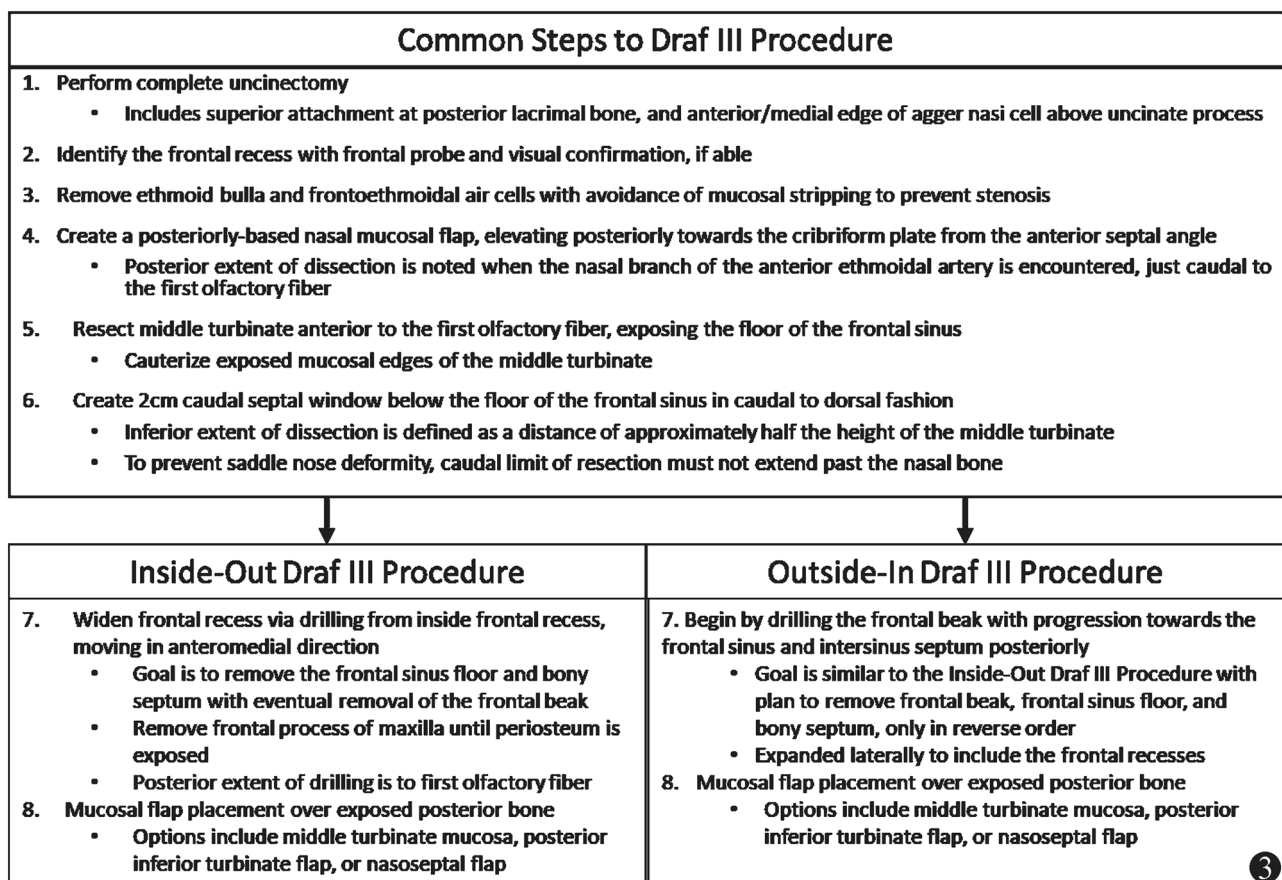


FIGURE 3 Common steps to the Draf III procedure

septal support. These boundaries can be outlined with a Colorado Bovie fine tip before making the window.

Before drilling the frontal sinus floor, the entire area must be exposed. First, the posterior extent of the Draf III must be delineated. The anterior septal angle at the junction of the dorsal and caudal portions of the nasal septum is identified and a mucosal flap is posteriorly elevated toward the cribriform plate with a suction-freer elevator. As the surgeon approaches the cribriform plate, the nasal branch of the anterior ethmoid artery will be encountered first, just anterior to the first olfactory fiber. The first olfactory fiber delineates the posterior-most extent of the Draf III, but the nasal branch of the anterior ethmoid artery is often confused with the first olfactory fiber given their close proximity.⁸

Next, the attachment of the middle turbinate that is anterior to the defined first olfactory fiber is resected. With the removal of the middle turbinate attachment, the frontal sinus floor superiorly is properly exposed for later drilling. The mucosal edges of the middle turbinate surrounding the axilla are cauterized.

The frontal sinus should be drilled to its maximum limits using a combination of the angled endoscopes and the drill. It is easiest to maneuver the instruments by placing the endoscope in one nostril and the drill in the other nostril. As defined by the "inside-out" label, the drilling is done from inside the frontal recess, drilling in an anteromedial direction toward the contralateral frontal sinus. A 15° 4-mm cutting burr can quickly remove dense bone, but different angled burrs may be necessary at different points. The entire frontal beak, frontal sinus floor, and bony septum should be removed, ensuring a smooth transition between the nasal bone and anterior frontal table. The frontal process of the maxilla should also be removed until the periosteum is exposed.⁸ A 4-mm

diamond burr is used while drilling the posterior frontal sinus floor anterior to the first olfactory fiber, due to the vulnerable anatomy at this location. Finally, the intersinus septum is removed in its entirety.

As the common frontal sinus opening can scar down, pedicled mucosal grafts have been shown to help prevent stenosis and crusting.²²⁻²⁴ Multiple pedicled flaps can be used, including a posterior inferior turbinate flap, a middle turbinate flap, or a nasoseptal flap. Finally, dissolvable Nasopore soaked in triamcinolone 40, silastic stents, or another similar product is placed into the frontal sinus over the pedicled flap to further prevent scarring and reduce inflammation during the healing process. Following completion of the surgery, the frontal sinuses should be widely patent to facilitate evaluation and debridement in the clinic setting.

THE OUTSIDE-IN DRAF III PROCEDURE

The main indication for the outside-in procedure is a narrow frontal recess that cannot easily or safely accommodate frontal sinus instruments or drills. The steps of the procedure are identical to the inside-out procedure up to the point of drilling. However, drilling should begin not within the frontal recess, but instead at the frontal beak. The frontal sinus and intersinus septum are drilled out to completion, back to the posterior limit of the first olfactory fiber. Once the drill-out is complete, the neostium is expanded laterally to include the frontal recesses.²⁵ The common frontal sinus can then be covered with a pedicled mucosa flap and NasoPore, similar to the inside-out procedure (Figure 4).

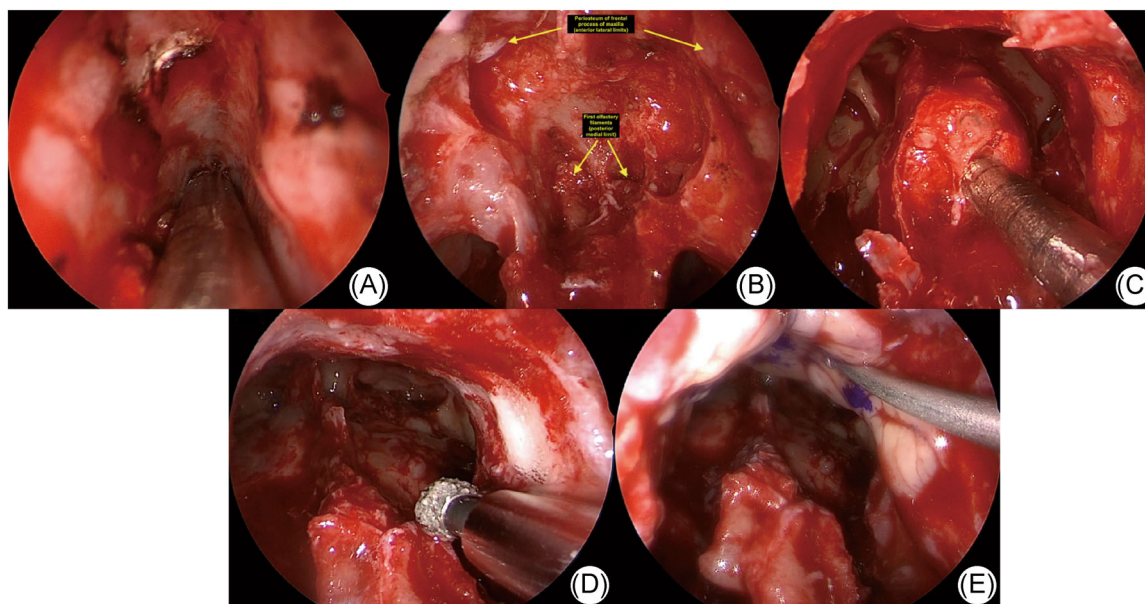


FIGURE 4 Endoscopic visualization of an outside-in approach to the Draf III procedure. (A) The extent of dissection posteriorly towards the first olfactory root is performed bilaterally. The extent of exposure extends from the bilateral olfactory roots posteromedially to the anterolateral frontal process of the maxilla (B). Once adequate exposure is obtained, the tissue between these limits should be removed (area indicated by suction in (C)). The excess bone should be drilled down and saucerized to remove any areas that may obscure visualization or drainage (D). Finally, a mucosal graft can be applied to the frontal beak (E) (Property of Columbia University Division of Rhinology)

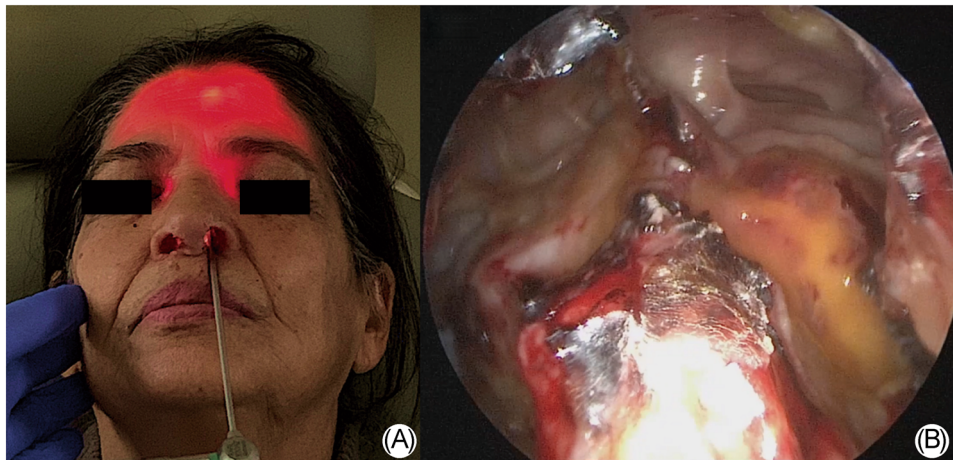


FIGURE 5 One-week postoperative examination of the patient after the Draf III procedure. Endoscopic transillumination of frontal sinuses (A) depicting widely patent common frontal sinus cavity and visualization of frontal sinus cavity (B) (Property of Columbia University Division of Rhinology)

POSTOPERATIVE MANAGEMENT

Patients can generally be discharged home on the day of surgery following successful recovery in the postanesthesia care unit. Some surgeons continue to recommend a course of postoperative antibiotics and/or steroids,¹⁴ although the use of prophylactic antibiotics after sinus surgery, in general, has been recently called into doubt.²⁶ Topical corticosteroids and nasal saline lavages should be initiated 1 week postoperatively. Follow-up appointments are dependent on the operating surgeon, but should generally follow the schedule of 1 week, 1 month, and 3 months, with debridements occurring at these visits. The frontal sinuses should be easily visualized via endoscopic visualization in the clinic with either a 0° or 30° endoscope (Figure 5).

COMPLICATIONS

Multiple anatomic sites are vulnerable to injury during the Draf III procedure itself, especially at the limits of dissection. The anterior ethmoid artery is located at the posterior-most extent of dissection, with its nasal branch just anterior to the first olfactory fiber. Injury to the anterior ethmoid artery can lead to retraction of the injured vessel behind the orbit, potentially causing a retro-orbital hematoma. The surgeon should promptly recognize this complication and intervene as necessary to prevent long-term vision issues. As the first olfactory fiber is the posterior limit of dissection, patients may experience short- or long-term hyposmia and/or anosmia. The lamina papyracea is the lateral most extent of dissection. Violation of the lamina can lead to injury of the orbit itself or the surrounding extraocular muscles. Finally, injury of the skull base can occur, resulting in a cerebrospinal fluid leak. Repair should be performed immediately if identified at the time of surgery.

The most significant complication during the postoperative course is neo-ostium stenosis, which has been reported to occur up

to 2 years following the Draf III procedure,^{27,28} and leads to revision surgery 5%–30% of the time.^{27,29} Achieving an opening of the frontal sinus, approximately 21.0 mm × 19.5 mm, may result in decreased stenosis and the need for revision surgery.¹⁰ Regular debridement in the clinic accompanied by consistent intranasal steroid use can mitigate the likelihood of stenosis. In the first 2–3 months specifically, a fibrotic web can develop over the nasal fontal beak, which increases the possibility of Draf III failure. This web should be addressed with intralesional steroid injection,¹⁴ repeat debridement, and close follow-up.

CONCLUSIONS

The Draf III procedure has expanded from its introduction in 1991 to allow surgical management of not just recalcitrant CRS, but also a variety of tumors and frontal sinus fractures. In addition, the development of the inside-out technique versus the outside-in technique since Draf's original paper has helped surgeons use the Draf III procedure for these expanded indications regardless of the diameter of a patient's frontal recess. As endoscopic management of rhinological diseases continues to progress, the indications and techniques for the Draf III procedure are sure to expand.

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CONFLICT OF INTERESTS

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