

What is the Current Place of Endonasal Frontal Sinus Surgery?

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ABSTRACT

Endonasal approaches to the frontal sinuses have evolved rapidly over the past 40 years and with ongoing improvements in technology continue to do so. However, clinical situations remain where the rhinologist will be faced with pathology more appropriately treated through open or combined approaches. This article summarises the current approaches, both open and endonasal.

Keywords: Endonasal, External approach, Frontal sinus

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INTRODUCTION

Surgical approaches to the frontal sinus are some of the more challenging rhinological procedures for the otolaryngologist due to the complex and highly variable frontal sinus drainage pathway. Historically, surgery on the frontal sinus has involved an open external approach with visible scars and often associated bony deformities.^{1,2} The advances in endoscope technology, imaging, intra-operative navigation systems, high-definition monitors, and anesthetic techniques have allowed the boundaries of endoscopic frontal sinus surgery to be moved to such an extent that they are now the mainstay. Notwithstanding this, we have not yet reached the point that the open approach has become obsolete; far lateral lesions remain very difficult to reach endoscopically, as is surgery complicated by extensive fibrosis typical of revision surgery. This progression to favoring endoscopic approaches, with open surgery held in reserve, is similar to that seen in many surgical disciplines as our equipment, knowledge, and close cooperation with patients facilitate it. We are currently within the robotic surgical era. Although the

available surgical robots are clearly too large for endoscopic sinonasal surgery, their evolution will no doubt bring some excellent new tools for us to investigate.

Endonasal approaches to the frontal sinus have been popularized by pioneers, and in particular Draf, who first described the classification system in the early 1990s,³ ranging from a more simple endoscopic frontal sinusotomy through to median drainage procedures. Since this time, reports of endonasal techniques have quadrupled in the published literature with similar complication rates and outcome data to their open counterparts.⁴ More recently, the balloon sinuplasty procedure has been introduced as a theoretically more conservative surgical option, although its role is somewhat debatable, with arguments both for and against its effectiveness.^{5,6} Frontal sinus drainage procedures are typically utilized in a stepwise 'ladder' approach, with the simplest feasible option being chosen first and more complicated surgeries being reserved for increasing pathological complexity or in revision surgery (Table 1).

DRAF 1

The Draf 1 procedure is the simplest endonasal approach to the frontal sinus and, as a result, preserves the most

Table 1: Indications for endonasal frontal sinus procedures adapted from Stilianos Kountakis⁷

Type of drainage	Indication
Draf 1	<p><i>Acute sinusitis</i></p> <ul style="list-style-type: none"> • Failure of conservative treatment • Orbital and intracranial complications <p><i>Chronic rhinosinusitis</i></p> <ul style="list-style-type: none"> • Index frontal sinus procedure • No adverse patient mucosal factors (e.g., Samter's triad) • Revision after ethmoidectomy
Draf 2	<ul style="list-style-type: none"> • Medial frontal muco/pyoceles • Benign tumors of the frontal sinus • Access to the posterior table of the frontal sinus • Significant acute frontal sinusitis complications
Draf 3	<ul style="list-style-type: none"> • Revision of a Draf 1 procedure • Complex revision surgery • Unfavorable patient mucosal factors (Samter's triad, etc.) • Benign and malignant tumors—medial to the level of the lamina papyracea

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mucosa within the frontal recess. It should be considered and used where possible, since preservation of healthy frontal sinus recess mucosa will reduce the risk of restenosis and subsequent more complex revision surgery. Classically, this approach describes clearing the frontal recess by opening the anterior ethmoidal air cells and resecting part of the uncinat process and any cells within the frontal recess. The agger nasi cell is typically left alone as is the floor of the frontal sinus (Fig. 1). A Draf 1 drainage procedure may be indicated for both acute frontal sinusitis (failure of conservative treatment and occasionally orbital/intracranial complications) and chronic rhinosinusitis, index frontal sinus procedures, revision surgery following incomplete ethmoidectomy, and no adverse patient mucosal factors, such as Samter's triad (nasal polyposis, asthma, and aspirin intolerance).⁷

DRAF 2

Draf 2 procedures are more complex and require removal of all cells within the frontal recess up to the natural frontal sinus ostium. The Draf 2 classification is subdivided into 2A and 2B. A Draf 2A procedure extends the initial steps of a Draf 1 plus resecting the cells in the frontal recess lateral to the middle turbinate. The Draf 2B is an extension of the 2A so that the dissection removes the floor of the frontal sinus to clear a path between the orbit laterally to the nasal septum inferomedially and frontal sinus septum superomedially. Typically, the floor of the frontal sinus is resected. The Draf 2B approach is more commonly utilized than the 2A as frontal sinus pathology, which requires the floor of the sinus to be resected, often includes active mucosal inflammation and fibrosis of the drainage pathway having a tendency to circumferentially stenose. Therefore, the wider drainage is recommended for the best outcome. Indications for type II Draf procedures include medial frontal muco/pyoceles,



Fig. 1: Postoperative view of an endonasal Draf 1 procedure looking into the frontal sinus via its ostium anteriorly

benign tumors of the frontal sinus, access to the posterior table of the frontal sinus, significant acute frontal sinusitis complications, or revision of a Draf 1 procedure.

DRAF 3

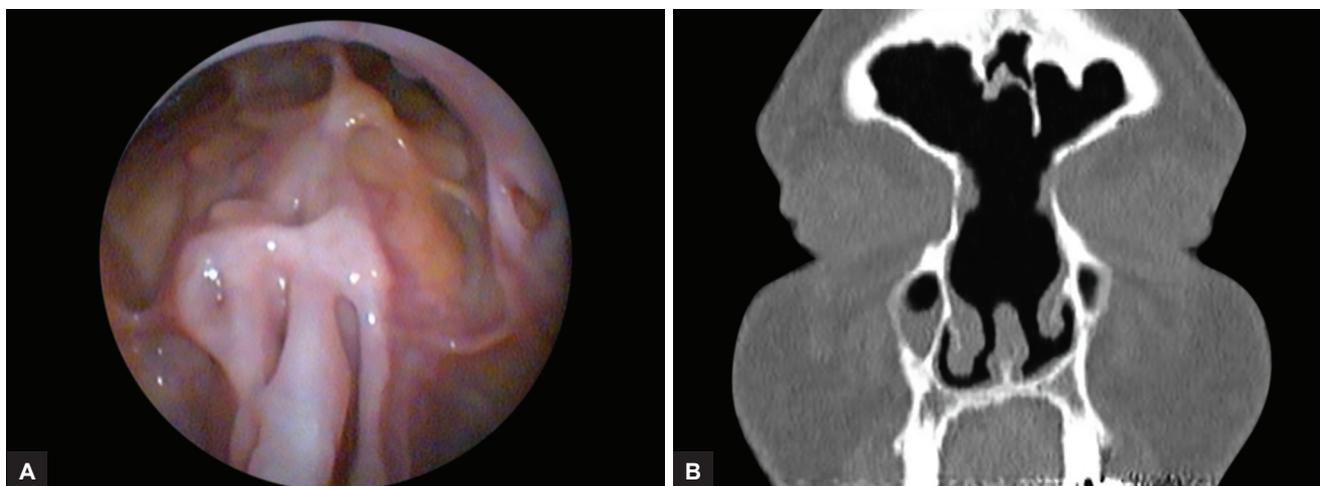
The final procedure in the Draf classification is to establish a median drainage pathway between both frontal sinuses essentially by performing bilateral Draf 2B operations and removing the frontal sinus septum and a superior portion of the nasal septum. By performing these steps, a wide drainage pathway is established from the common frontal sinus (Fig. 2). Similarly, by utilizing approaches through each of the nasal cavities, inspection and manipulation of the lateral aspects of the sinus can be performed. The Draf 3 has a number of synonyms ("endoscopic modified Lothrop" and "frontal sinus drill out"), which can make frontal sinus surgery nomenclature confusing, though they are essentially the same operative steps. A Draf 3 drainage procedure would be indicated for complex revision surgery, where there are unfavorable patient mucosal factors, such as Samter's triad, primary ciliary dyskinesia, and for some benign and malignant tumors provided the tumor is medial to a line extended vertically upward from the lamina papyracea.

FRONTAL SINUS RESCUE PROCEDURE

The frontal sinus rescue operation was first described in the late 1990s as a potential alternative endonasal procedure to a Draf 3 approach, especially where there is scarring of the frontal sinus ostia from previous surgery.⁸ The operative steps include rotating a middle turbinate remnant flap into the cleared frontal sinus ostium to introduce new mucosal flaps and reposition the circumferential scar into a longitudinal pattern, with a similar effect to a z-plasty in conventional scar revision.⁹ To perform a frontal sinus rescue procedure, an incision is made along the length of the remaining middle turbinate, removing the bony lamella and associated medial mucosa to create a laterally based flap. The remaining lateral middle turbinate mucosa is then rotated out of the frontal ostium with the aim to prevent circumferential restenosis of the frontal drainage pathway.

SURGICAL ADJUNCTS

Due to the nature of inflammatory sinonasal mucosal disease, functional endoscopic sinus surgery alone is often not possible to provide a complete cure from chronic rhinosinusitis. Careful postoperative care, primarily with topical corticosteroids and saline irrigation, is the current mainstay of treatment to maintain sinus ventilation.¹⁰ As the mucosal immunology and pathophysiology of



Figs 2A and B: (A) Postoperative view of an endonasal Draf 3 procedure and views into the common frontal sinus cavity; (B) postoperative coronal computed tomography scan

sinonasal inflammation are being uncovered, novel monoclonal antibody biological treatments are being tested in clinical trials¹¹⁻¹⁴ that may offer therapeutic breakthroughs for this group of patients with upper respiratory and sinonasal diseases. In addition to medical treatments, there is debate surrounding the use of drug-eluting stents with proponents, who suggest that they help establish healthy mucosa and prevent restenosis of the frontal sinus. Similarly, there are surgeons who find their use detrimental. At present, there is no level 1 evidence in place to support their application, and use is, therefore, determined by local expertise.¹⁵ It is highly likely that as newer anti-inflammatory agents come along, there will be trials of such drug-eluting stents and similar surgical adjuncts.

BALLOON SINUPLASTY

Balloon sinuplasty is a relatively recent addition to the endonasal surgical treatment options of the frontal sinus.¹⁶⁻¹⁸ Similar to coronary artery angioplasty, a balloon catheter is directed into the area of stenosis and inflated to attempt to dilate the frontal sinus drainage pathway. It is technically less demanding than conventional endoscopic endonasal approaches to the frontal sinus and has both advocates and critics. Supporters of balloon sinuplasty suggest it is a conservative, mucosa-preserving procedure that can be quickly performed.¹⁹ However, critics have reported that it is often not effective and one feasibility trial planned for 200 patients had to be aborted early, after only 45 patients, once a 65 to 66% failure rate was identified.²⁰

OUTCOMES—ENDONASAL APPROACHES

Traditional external frontal sinus drainage procedures historically provided reasonable short-term success rates,

though over time approximately a third would stenose and fail. The longer term outcomes of these procedures increased the popularity of more extensive open procedures, such as the osteoplastic flap and frontal sinus obliteration surgeries.²¹ More extensive open procedures are not without risk and the developments in endoscopic surgery provided possible newer more functional alternatives. The outcomes of endonasal frontal sinus surgery have typically been reported in single-surgeon or single-institution case series over the last two decades.²²⁻²⁶ The evidence has been recently reviewed by DeConde and Smith,²⁷ who have identified data that support that Draf 2 drainage procedures provide both lasting frontal sinus patency in clinic endoscopy and patients' quality-of-life outcomes. Outcomes for Draf 3 procedures show a similar improvement at least up to 2 years postoperatively in 85% of patients. Higher patency rates up to 97% (221 out of 229 patients) have been reported in those who have larger frontal drainage pathways measuring up to 20 × 20 mm.²⁸

OPEN APPROACHES—THE OSTEOPLASTIC FLAP

Over the past three decades, endonasal approaches have revolutionized the management of frontal sinus disease. However, it is widely recognized that there are a number of instances where open approaches are still required. It is essential that the rhinologist is familiar with open techniques; otherwise, there is a risk that patients will not be offered the appropriate options in the management of their underlying condition (Fig. 3).

Goodale and Montgomery¹ popularized the osteoplastic anterior wall approach to the frontal sinus (Fig. 4) in the 1950s. While this had been described at the beginning of the 19th century, concerns about the extent of the procedure and risks of osteomyelitis meant that it was



Figs 3A and B: Coronal computed tomography scan images demonstrate a far lateral mucocoele of the frontal sinus with intraorbital extension and inferior displacement of the globe within the orbit (A) preoperatively and (B) postoperatively. There is a rolled silastic stent to maintain the patency of drainage of the mucocoele into the lateral frontal sinus, approached externally through an osteoplastic flap procedure

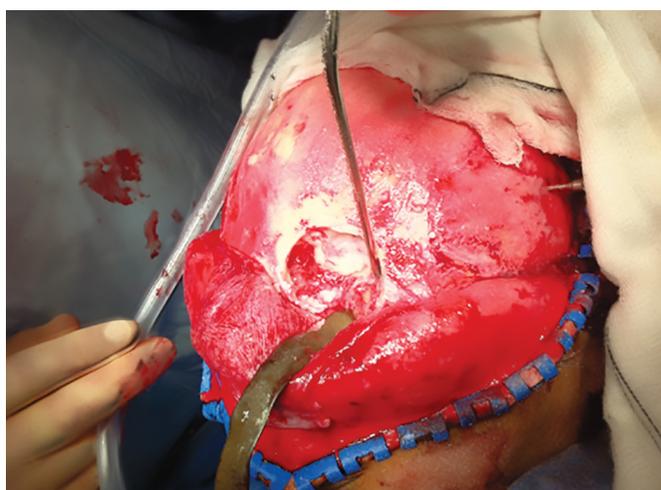


Fig. 4: Intraoperative photo of an osteoplastic flap procedure via a bicoronal incision. The sucker and malleable retractor are inserted into the edges of the frontal sinus with the outer table bone having been removed with intraoperative navigation guidance. The anterior bone segment will be inserted to the defect with miniplates and screws at the end of the procedure once the mucosa has been removed from its posterior wall and the flap replaced. The blue Raney scalp clips are applied for hemostasis intraoperatively

rarely performed. However, these concerns were largely dismissed in the 1960s as the procedure gained popularity and failure rates of less than 10% were described.

The advent of an increasing experience with endonasal minimally invasive procedures led to a recognition that many pathologies previously treated through open approaches could now be performed endoscopically. The osteoplastic flap increasingly fell out of regular use in many centers as rhinologists became less familiar with this technically challenging procedure.

The osteoplastic flap may be combined with obliteration of the frontal sinus by fat or other material. Traditionally, obliteration was the technique of choice in an attempt to ensure that there was no recurrence of symptoms from the treated pathology. However, complications, such as

postoperative mucocoele formation are such that long-term follow-up is required and subsequent “unobliteration” procedures may be necessary. Care must be taken at the primary open operation to ensure that all frontal sinus mucosa is removed by drilling it away and ensuring the frontal sinus exit is sealed from the frontal recess. Ideally, obliteration should be restricted to those procedures where communication with the frontal drainage pathway cannot be ensured. In the author’s experience, the majority of frontal sinus osteoplastic flap cavities can be combined with endonasal frontal sinus outflow procedures, e.g., Draf type III, to enable ongoing mucociliary drainage and regular endonasal inspection of the frontal sinus.

OUTCOMES—EXTERNAL APPROACHES

Ochsner and DelGaudio²⁹ reported on 73 procedures in 57 patients over a 15-year period. They highlighted the benefit of this approach to treat endoscopically inaccessible areas or for refractory pathology. However, they noted 17% required further procedures/revisions, particularly if the open procedure had been performed for inflammatory causes. Smaller series are also reported by Hahn et al³⁰ and Silverman et al.³¹ Overall, the osteoplastic flap procedure still has a valuable place to play in the contemporary management of challenging frontal sinus condition. However, its selection should be based upon the nature of the pathology, and its use is dependent upon appropriate anatomical factors.

CONCLUSION

Endonasal surgery of the frontal sinus is technically demanding, and has evolved since its introduction in the late 20th century. This is due to advances in both available surgical equipment and techniques. Careful analysis of the

technical and patient symptom outcomes has provided useful information to help guide surgeons choose the best approach to the frontal sinus. For each patient, thought should be given to the least invasive approach to address pathology of the frontal sinuses. Currently, for the majority of frontal sinus surgery indications, we would recommend endonasal surgery with open approaches held in reserve.

REFERENCES

- Goodale RL, Montgomery WW. Experiences with the osteoplastic anterior wall approach to the frontal sinus; case histories and recommendations. *AMA Arch Otolaryngol* 1958 Sep;68(3):271-283.
- Hardy JM, Montgomery WW. Osteoplastic frontal sinusotomy: an analysis of 250 operations. *Ann Otol Rhinol Laryngol* 1976 Jul-Aug;85(4 Pt 1):523-532.
- Draf W. Endonasal micro-endoscopic frontal sinus surgery: the Fulda concept. *Oper Tech Otolaryngol Head Neck Surg* 1991 Dec;2(4):234-240.
- Courson AM, Stankiewicz JA, Lal D. Contemporary management of frontal sinus mucoceles: a meta-analysis. *Laryngoscope* 2014 Feb;124(2):378-386.
- Vaughan WC. Review of balloon sinuplasty. *Curr Opin Otolaryngol Head Neck Surg* 2008 Feb;16(1):2-9.
- Ahmed J, Pal S, Hopkins C, Jayaraj S. Functional endoscopic balloon dilation of sinus ostia for chronic rhinosinusitis. *Cochrane Database Syst Rev* 2011 Jul;(7):CD008515.
- Stilianos Kountakis BSWD. *The frontal sinus*. Berlin: Springer; 2005.
- Citardi MJ, Javer AR, Kuhn FA. Revision endoscopic frontal sinusotomy with mucoperiosteal flap advancement: the frontal sinus rescue procedure. *Otolaryngol Clin North Am* 2001;34(1):123-132.
- Kuhn FA, Javer AR, Nagpal K, Citardi MJ. The frontal sinus rescue procedure: early experience and three-year follow-up. *Am J Rhinol* 2000 Jul-Aug;14(4):211-216.
- Fokkens WJ, Lund VJ, Mullol J, Bachert C, Alobid I, Baroody F, Cohen N, Cervin A, Douglas R, Gevaert P, et al. European position paper on rhinosinusitis and nasal polyps 2012. *Rhinology* 2012 Mar;50(1):1-12.
- Bachert C, Sousa AR, Lund VJ, Scadding GK, Gevaert P, Nasser S, Durham SR, Cornet ME, Kariyawasam HH, Gilbert J, et al. Reduced need for surgery in severe nasal polyposis with mepolizumab: Randomized trial. *J Allergy Clin Immunol* 2017 Oct;140(4):1024-1031.e14.
- Bachert C, Mannent L, Naclerio RM, Mullol J, Ferguson BJ, Gevaert P, Hellings P, Jiao L, Wang L, Evans RR, et al. Effect of subcutaneous dupilumab on nasal polyp burden in patients with chronic sinusitis and nasal polyposis: a randomized clinical trial. *JAMA* 2016 Feb;315(5):469-479.
- Gevaert P, Calus L, Van Zele T, Blomme K, De Ruyck N, Bauters W, Hellings P, Brusselle G, De Bacquer D, van Cauwenberge P, et al. Omalizumab is effective in allergic and nonallergic patients with nasal polyps and asthma. *J Allergy Clin Immunol* 2013 Jan;131(1):110-116.e1.
- Pauwels B, Jonstam K, Bachert C. Emerging biologics for the treatment of chronic rhinosinusitis. *Exp Rev Clin Immunol* 2015 Mar;11(3):349-361.
- Huang Z, Hwang P, Sun Y, Zhou B. Steroid-eluting sinus stents for improving symptoms in chronic rhinosinusitis patients undergoing functional endoscopic sinus surgery. *Cochrane Database Syst Rev* 2015 Jun;(6):CD010436.
- Luong A, Batra PS, Fakhri S, Citardi MJ. Balloon catheter dilatation for frontal sinus ostium stenosis in the office setting. *Am J Rhinol* 2008 Nov-Dec;22(6):621-624.
- Catalano PJ, Payne SC. Balloon dilation of the frontal recess in patients with chronic frontal sinusitis and advanced sinus disease: an initial report. *Ann Otol Rhinol Laryngol* 2009 Feb;118(2):107-112.
- Stankiewicz J, Tami T, Truitt T, Atkins J, Liepert D, Winegar B. Transantral, endoscopically guided balloon dilatation of the ostiomeatal complex for chronic rhinosinusitis under local anesthesia. *Am J Rhinol Allergy* 2009 May-Jun;23(3):321-327.
- Weiss RL, Church CA, Kuhn FA, Levine HL, Sillers MJ, Vaughan WC. Long-term outcome analysis of balloon catheter sinusotomy: two-year follow-up. *Otolaryngol Head Neck Surg* 2008 Sep;139(3 Suppl 3):S38-S46.
- Tomazic PV, Stammberger H, Braun H, Habermann W, Schmid C, Hammer GP, Koele W. Feasibility of balloon sinuplasty in patients with chronic rhinosinusitis: the Graz experience. *Rhinology* 2013 Jun;51(2):120-127.
- Chiu AG. Frontal sinus surgery: its evolution, present standard of care, and recommendations for current use. *Ann Otol Rhinol Laryngol Suppl* 2006 Sep;196:13-19.
- Naidoo Y, Wen D, Bassiouni A, Keen M, Wormald PJ. Long-term results after primary frontal sinus surgery. *Int Forum Allergy Rhinol* 2012 May-Jun;2(3):185-190.
- Jacobs JB. 100 years of frontal sinus surgery. *Laryngoscope* 1997 Nov;107(11 Pt 2):1-36.
- Friedman M, Bliznikas D, Vidyasagar R, Joseph NJ, Landsberg R. Long-term results after endoscopic sinus surgery involving frontal recess dissection. *Laryngoscope* 2006 Apr;116(4):573-579.
- Chan Y, Melroy CT, Kuhn CA, Kuhn FL, Daniel WT, Kuhn FA. Long-term frontal sinus patency after endoscopic frontal sinusotomy. *Laryngoscope* 2009 Jun;119(6):1229-1232.
- Askar MH, Gamea A, Tomoum MO, Elsherif HS, Ebert C, Senior BA. Endoscopic management of chronic frontal sinusitis: prospective quality of life analysis. *Ann Otol Rhinol Laryngol* 2015 Aug;124(8):638-648.
- DeConde AS, Smith TL. Outcomes after frontal sinus surgery: an evidence-based review. *Otolaryngol Clin North Am* 2016 Aug;49(4):1019-1033.
- Naidoo Y, Bassiouni A, Keen M, Wormald PJ. Long-term outcomes for the endoscopic modified Lothrop/Draf III procedure: a 10-year review. *Laryngoscope* 2014 Jan;124(1):43-49.
- Ochsner MC, DelGaudio JM. The place of the osteoplastic flap in the endoscopic era: indications and pitfalls. *Laryngoscope* 2015 Apr;125(4):801-806.
- Hahn S, Palmer JN, Purkey MT, Kennedy DW, Chiu AG. Indications for external frontal sinus procedures for inflammatory sinus disease. *Am J Rhinol Allergy* 2009 May-Jun;23(3):342-347.
- Silverman JB, Gray ST, Busaba NY. Role of osteoplastic frontal sinus obliteration in the era of endoscopic sinus surgery. *Int J Otolaryngol* 2012;2012:501896.