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What is This?
The Draf III Mucosal Grafting Technique: A Prospective Study

Bryant T. Conger Jr, MD1, Kristen Riley, MD2, and Bradford A. Woodworth, MD1

Abstract

Objective. The Draf III procedure is an advanced surgical option for frontal sinus disease refractory to endoscopic frontal sinusotomy and is used to expose the anterior limit of resection of the skull base during endoscopic management of anterior skull base tumors. Our objective was to evaluate outcomes of a strategy using mucosal grafts to decrease postoperative closure.

Study Design. Prospective cohort.

Setting. Tertiary care facility.

Subjects and Methods. Patients requiring a Draf III procedure were prospectively enrolled in the study. Demographics, reason for the procedure, percentage graft viability, and complications were recorded. The primary outcome measure was anterior-posterior (AP) diameter at 3 months.

Results. Mucosal grafting was performed during 29 Draf III procedures from 2008 to 2011. Twenty-seven patients (average age, 58 years) were available for measurement at 3 months (average postoperative follow-up, 15.4 months; range, 3–30 months). Reasons for the procedure included tumor (n = 14), chronic rhinosinusitis (CRS) with frontal ostium stenosis (n = 12), and trauma (n = 1). Average intraoperative AP diameter was 11.7 mm. All patients met the definition of success (<50% reduction in diameter), maintaining a patent combined frontal sinus ostium for the duration of follow-up (average diameter 10.8 mm at 3 months). Nine patients with CRS and frontal ostium stenosis had openings similar to the entire cohort (>1-year follow-up; average, 19.3 months) with significant symptom reduction (SNOT-22 preop 62.3 ± 20.8 vs 3 months 27.8 ± 14.8 and 1 year 21.4 ± 13.6; P < .0001).

Conclusion. Cicatricial stenosis and osteoneogenesis are common following the Draf III procedure. This study indicates that the use of mucosal grafts may assist with postoperative stenosis and should be considered a routine strategy for preventing closure.

Keywords

sinusitis, skull base, frontal sinus, sinusotomy, sinus surgery, nasal endoscopy, Lothrop, Draf III
tumor and to prevent postoperative iatrogenic frontal sinus disease.\textsuperscript{3,8} While less invasive than frontal sinus obliteration, the Draf III procedure is not without its own set of complications. Osteoneogenesis and persistent mucosal disease can cause narrowing or closure of the frontal sinus outflow tract.\textsuperscript{9} In a systematic review of Draf III procedures reported in the literature that included 18 studies and 612 patients, it was found that 19\% of patients had stenotic or closed frontal sinus ostia at the last clinical follow-up.\textsuperscript{10} Furthermore, revision was required in 14\% of patients. In a study by Casiano and Livingston,\textsuperscript{11} 12 of 21 patients had a Draf III stenosis that was >50\% of the intraoperative size.

We describe a modification of the Draf III procedure in which mucosal grafts are used to potentially decrease postoperative closure from cicatricial stenosis and osteoneogenesis. The objectives of the present study were to prospectively evaluate postoperative stenosis and surgical outcomes regarding this technique.

**Methods**

**Subjects and Outcome Measures**

Prospective evaluation and data collection of study subjects was approved by the University of Alabama at Birmingham Institutional Review Board. Adult patients >18 years of age undergoing the Draf III procedure for infectious, inflammatory, or neoplastic disease were prospectively enrolled in the study (2008-2011). Demographics, indication for surgery, Lund-McKay computed tomography scores, intraoperative and postoperative AP diameters, percentage mucosal graft survival, postoperative follow-up times, and complications were collected. In patients with chronic rhinosinusitis (CRS) and frontal ostium stenosis (Figure 1), symptoms were evaluated with the Sinonasal Outcome (SNOT)-22 questionnaire\textsuperscript{12,13} administered before surgery and during postoperative visits. Preoperative questionnaires were given after completion of aggressive medical treatment. Total scores were analyzed using paired \( t \) tests. The primary outcome measure included postoperative stenosis at 3 months (defined by <50\% original diameter). The intraoperative diameter of the Draf III was measured with a ruler placed endoscopically within the extended frontal cavity in the midline. When the cribriform and a portion of the posterior table were resected as part of tumor extirpation, the diameter was measured from the skull base repair at the level of the anterior aspect of the cribriform as it transitions to the posterior table. Office endoscopy with a 70\° scope and ruler cut to size was used to evaluate the postoperative diameter and the percentage viability of the mucosal grafts. In the case of skull base repair, the diameter was measured from the plane of the drilled frontal beak to the anterior aspect of the repair at the level of the resected anterior cribriform. Viability was measured like a full-thickness skin graft, and the percentage was determined as a rough estimate of graft necrosis and subsequent bone exposure postoperatively during the first debridement.

**Surgical Technique**

The technique for the Draf III procedure was performed as previously reported with modifications as described below.\textsuperscript{14,15} (Figure 2). The septal mucosa was harvested as part of the upper septectomy or from the posterior third of the inferior turbinate in the setting of a prior Draf III or unusable mucosa from tumor extirpation. The nasal septal mucosa overlying the upper septectomy site was sharply incised with Beaver blades under endoscopic visualization. The grafts were then removed with a suction elevator in the subperichondrial and subperiosteal planes. Orientation was marked so that the direction of mucociliary flow was known. The graft was placed in a bowl of normal saline in a tray of ice until completion of the Draf III procedure.

A unilateral frontal sinusotomy was performed using a 70\° scope and a combination of frontal recess dissection instruments and a 70\° diamond burr, if necessary. The nasofrontal beak was drilled off with the 70\° burr as part of the Draf III procedure, and bone removal was then carried over to the intersinus septum. The cartilage and bone remaining in the upper septum were then removed. In a similar fashion to the first side, the contralateral frontal sinusotomy and frontal recess dissection were performed and the frontal beak was further drilled to the intersinus septum to widen the Draf III. The posterior mucosa of the posterior table was carefully preserved throughout the procedure unless it was removed as part of tumor resection, in which case it was replaced with a nasoseptal flap skull base repair.

The mucosal grafts were positioned over the exposed bone where the nasofrontal beak was drilled away. The graft was oriented to ensure mucociliary flow in an inferior direction. Evicel fibrin sealant (Johnson & Johnson Wound Management, Somerville, NJ) was applied to the graft and surrounding tissues. Finally, 0.5-mm cut-to-fit silastic frontal sinus stents were placed to provide support to the mucosal grafts and bilateral middle meatal cotton spacers in a nonlatex glove finger inserted into the middle meatus. Spacers and silastic stents were removed at the first visit 8 to 13 days postoperatively.
Results

From 2008 to 2011, 29 patients underwent the Draf III mucosal grafting technique by a single otolaryngologist (B.A.W.). Etiologies included skull base and sinus tumors with or without concomitant CRS (n = 14), CRS with frontal ostium stenosis (n = 12), and traumatic injury (n = 1). Twenty-seven patients (average age, 58 years; 15 women/12 men) completed 3 months of clinical follow-up (overall 14 months) and were included in the prospective analysis (Table 1). Average preoperative Lund-McKay score was 11.1. Average intraoperative AP diameter was 11.7 mm, and average postoperative diameter was 10.8 mm. Three patients had partial graft loss. All patients in the study met the definition of success (closure less than 50%) with no revisions required throughout the follow-up period (Figure 3). Twelve patients had Draf III procedures for CRS and frontal ostium stenosis (all revision surgeries), with 9 subjects available for clinical follow-up >1 year postsurgery (mean of 19.3 months). The average postoperative change in diameter (11.2 to 10.7 mm, 5% decrease) was not appreciably different when compared with subjects in whom a Draf III was performed for tumor resection (11.9 to 11 mm, 8.5% decrease; P = .36). In addition, these patients also had significant symptom reduction at 1 year on SNOT-22 scores (mean preop 62.3 ± 20.8 vs 3 months 27.8 ± 14.8 and 1 year 21.4 ± 13.6; P < .0001; Figure 4).

Discussion

The Draf III procedure is now considered the salvage endoscopic procedure of choice for severe frontal ostium stenosis in the setting of failed frontal sinus procedures. In addition, the approach is often required during removal of tumors with bilateral involvement of the skull base due to the propensity for closure after removal of mucosa.3-7 The Draf III procedure typically preserves posterior table mucosa and the frontal sinus drainage pathway in the traditional endoscopic frontal sinusotomy, but the anterior and lateral aspect is left to mucosalize on its own, frequently leading to osteoneogenesis, scar tissue, and closure.10,11,16,17 Lee suggests that osteitic bone acts as an inflammatory center, initiating edema and hypertrophy of the adjacent mucosa, thus narrowing the frontal recess.18 Thus, revision Draf III procedures or subsequent open approaches are sometimes required for frontal stenosis. Methods for decreasing frontal stenosis and the need for further surgery would be of major benefit to surgeons performing the procedure.

Using an adaptation of the Draf III procedure where exposed bone is covered with mucosal grafts, the present prospective study demonstrated a 100% success rate in maintaining patency of the frontal sinus and preventing stenosis following the technique. In addition, patients with CRS and frontal ostium stenosis derived significant benefit on long-term follow-up (1 year) according to SNOT-22 questionnaires. The benefit of the procedure is emphasized by the successful revision of a completely stenotic Draf III
opening that had closed within 6 weeks of the procedure at an outside institution (patient 11). Following our revision, she had no change in AP diameter from initial intraoperative size (10 mm) throughout 20 months of clinical follow-up, providing strong support for the routine use of the strategy. Since the mucosal grafts line the new frontal outflow tract, exposed bone is minimized or even eliminated. Importantly, graft viability was very high in all patients, indicating proper imbibition after the procedure. Although not directly evaluated, the lack of exposed bone also appeared to decrease the crusting typically demonstrated for several months following the traditional surgery. All patients available for clinical follow-up after 3 months maintained the same diameter, indicating that this time point is likely adequate for evaluating closure.

Limitations of this prospective cohort include a small sample size, heterogeneity of the subject population (etiology, presence of infection), a disproportionately smaller number of chronic sinusitis patients compared with the general subject population, and the lack of a control group. In future studies, it will be important to further evaluate the impact of Draf III with mucosal grafting on the symptomatic improvement of patients undergoing the procedure for chronic inflammation in a larger cohort. Ongoing prospective enrollment and follow-up will increase our experience and determine the importance of this technique in the

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Abbreviations: CRS, chronic rhinosinusitus; OPF, osteoplastic flap.

Figure 3. A completely patent Draf III procedure (10 mm) is present at 22 months of clinical follow-up, and the patient remains symptom free.
frontal sinus algorithm. However, because the mucosal grafts are typically removed from the part of the septum eliminated as a component of the surgery, there should be no complications or morbidity that would be directly attributable to this technical variation and this study provides evidence of excellent benefit.

Conclusion

The mucosal grafting Draf III technique provided excellent outcomes in the current study. This approach should be considered a routine part of the treatment algorithm for frontal sinus pathology.

Author Contributions

Bryant T. Conger Jr, data collection, drafting of manuscript, final approval; Kristen Riley, data collection, critical review of manuscript, final approval; Bradford A. Woodworth, concept development, data collection, critical review of manuscript, final approval.

Disclosures

Competing interests: Dr Woodworth is a consultant for Gyrus ENT and ArthroCare ENT.

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References