Endoscopic Frontal Sinus Drillout in 100 Patients

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Objective: To determine the efficacy of frontal sinus drillout surgery for the treatment of chronic frontal sinusitis.

Design: Retrospective case-control study. Mean±SD follow-up was 4.1±1.53 years (range, 1.4-6.9 years).

Setting: Academic medical center.

Patients: One hundred consecutive patients with chronic sinusitis who underwent frontal sinus drillout surgery. Indications were failed previous frontal sinusotomy (n=88) and frontal sinus mucocele (n=12).

Interventions: Endoscopic removal of the floor of the frontal sinus (unilateral, n=34; bilateral, n=66) with a surgical drill. An intraoperative image-guidance system was used in 65 patients.

Main Outcome Measures: Frontal sinus patency and improvement of symptoms associated with frontal sinusitis.

Results: Frontal sinus patency with control of symptoms was achieved in 80% of patients. There were no intraoperative complications. Postoperative epistaxis occurred in 4% of patients. Of the 20 patients who developed restenosis of the frontal sinus ostium, 11 underwent revision frontal sinus drillout and 9 proceeded to frontal sinus obliteration. The success rate was comparable for the image-guidance and non–image-guidance groups (83.1% vs 74.3%, respectively; P=.56).

Conclusions: Frontal sinus drillout performed with or without an image-guidance system appears to be a safe and effective surgery for the treatment of patients with advanced disease of the frontal sinus. This procedure provides a reasonable alternative to frontal sinus obliteration, which remains a treatment option for patients who fail frontal drillout.

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Despite the introduction of endoscopic instrumentation for the treatment of sinus disease in the 1980s, surgery on the frontal sinus remains a clinical challenge because of the high rate of ostial restenosis with recurrent sinusitis. In the past, patients in whom frontal sinusotomy failed proceeded to frontal sinus obliteration with abdominal fat performed through an external incision. Although obliteration surgery is highly effective, the morbidity associated with the osteoplastic flap approach has prompted the development of less invasive intranasal procedures. In the early 1990s, Draf described an intranasal approach that used a microscope and drill to remove the floor of the frontal sinus, a portion of the superior nasal septum, and the interfrontal septum for treatment of advanced frontal sinus disease. Close et al and Gross et al described similar techniques using endoscopic instrumentation to create a large opening between the frontal sinuses and nasal cavity, referred to as the “modified Lothrop” or “frontal sinus drillout” procedure. Although some authors have advocated the use of these procedures as an alternative to frontal sinus obliteration, the long-term efficacy of such surgery remains unknown.

Endoscopic frontal sinus drillout can be a technically demanding procedure because of the narrow anatomy of the frontal recess, the angled field of view at which the surgeon operates, and the paucity of landmarks from previous surgery. Such a procedure appears to be well suited for image-guidance technology, which provides the surgeon with real-time feedback as to the position of the instrument in the operating field. The tip of the instrument, which may be a surgical drill, is depicted on a 3-dimensional video display of the patient's preoperative computed tomographic (CT) scan. Although image-guidance systems have been used...
for a variety of sinus procedures, their impact on frontal sinus drillout surgery has yet to be assessed. The purposes of this study were to evaluate the long-term efficacy of frontal sinus drillout and to determine the impact of image guidance on this surgery.

### METHODS

#### PATIENTS

A total of 100 patients underwent endoscopic frontal sinus drillout for treatment of advanced frontal sinusitis between June 1995 and March 2001. There were 46 men and 54 women with a mean ± SD age of 47.1 ± 13.3 years (range, 21-86 years). Surgical indications were chronic frontal sinusitis with opacification or air-fluid level following previous sinusotomy (88 patients) and frontal mucocele (12 patients). Patients with neoplasms were excluded. Ninety-two patients had undergone at least 1 prior sinus surgical procedure (Table). All study patients had preoperative nasal endoscopy and CT scans of the sinuses in the axial and coronal planes. Scans were classified as stage 0 through IV according to a previously described CT staging system (Table). Eight patients with stage I disease had unilateral frontal mucoceles with no history of previous sinus surgery.

#### PROCEDURES

A unilateral frontal sinus drillout was performed on 34 patients. The remaining 66 patients underwent bilateral drillouts (Figures 1, 2, and 3). The indications for a unilateral procedure were clinical and radiological evidence of chronic frontal sinusitis limited to one side with an asymptomatic aerated contralateral sinus. Patients with bilateral involvement or disease within a midline frontal compartment underwent a bilateral drillout procedure. All procedures were performed under general anesthesia by the senior author (R.M.). Success was defined as continued patency of the surgically created frontal sinus opening and improvement of the patient's preoperative symptoms of frontal sinusitis. Patency was confirmed by direct visualization (Figure 4) and probing of the frontal opening on postoperative endoscopic evaluations. Recurrence of symptoms with restenosis that required additional surgery was considered a failure. The mean ± SD follow-up was 4.1 ± 1.53 years (range, 1.4-6.9 years).

An optical-based image-guidance system (Landmarx; Medtronic Xomed, Jacksonville, Fla) was used during the performance of 65 frontal sinus drillouts between October 1996 and March 2001. The system used an infrared camera to track movement of the surgical instruments and the patient’s head through detection of light-emitting diodes. These light-emitting diodes were mounted on a headset worn by the patient and on surgical instruments, including a long-handled surgical drill. The location of the tip of the instruments was depicted on a video display of the patient's preoperative CT scan including 3-dimensional, axial, coronal, and sagittal views. The remaining 35 patients underwent endoscopic frontal sinus drillout surgery without the use of an image-guidance system. The selection of patients was dependent on access to an image-guidance system.

#### STATISTICAL ANALYSIS

The t test and Fisher exact test were used to compare patient characteristics between image-guidance and non-image-guidance groups. Time to failure was plotted in Kaplan-Meier survival curves and comparisons between groups were performed with log-rank and Wilcoxon tests.

### RESULTS

Frontal sinus patency and symptomatic improvement was achieved in 80% of patients who underwent frontal si-
nus drillout. Of the 20 patients who required additional surgery, 11 underwent revision frontal drillout and 9 underwent frontal sinus obliteration with abdominal fat through an osteoplastic flap approach.

The success rate was higher in women ($P = .04$) and in patients older than 45 years ($P = .047$). Although the difference in success rate between unilateral and bilateral drillout was not statistically significant ($P = .58$), all failures in the bilateral group occurred within 2 years, whereas failure in the unilateral group continued to be observed as late as 5 years after surgery (Figure 5). The CT stage was not found to impact on the surgical success rate.

A trend was observed toward a higher surgical success rate in the image-guidance group compared with the non–image-guidance group (83.1% vs 74.3%, respectively; $P = .56$) (Figure 6). Comparisons between image-guidance and non–image-guidance groups showed no significant differences in age, sex, CT stage, blood loss, number of prior sinus operations, or number of bilateral vs unilateral drillouts performed (Table). Registration of the image-guidance system provided anatomic localization to within 2-mm accuracy in all 65 cases where it was used.

There were no intraoperative complications. Four patients had postoperative epistaxis, 2 from the image-guidance group and 2 from the non–image-guidance group. In 3 patients epistaxis responded to local cauterization and nasal packing. One patient in the non–image-guidance group required endoscopic ligation of the sphenopalatine artery 1 week after surgery to control bleeding from the posterior remnant of a resected middle turbinate. The difference in complication rates between the 2 groups was not significant ($P = .83$).

Figure 1. Video display from image-guidance system depicts coronal, axial, sagittal, and 3-dimensional (3-D) views of the frontal sinus. The areas of bone removed during bilateral frontal sinus drillout shown in red, include the floor of frontal sinuses, interfrontal septum, and superior portion of the nasal septum.
Surgical treatment of patients with inflammatory disease of the frontal sinus usually consists of an anterior ethmoidectomy and clearing of agger nasi cells within the frontal recess. A frontal sinusotomy with enlargement of the frontal ostium may be performed for more advanced cases. Removal of the floor of the frontal sinus with a drill is reserved for patients with severe frontal sinusitis in whom previous surgery has failed and those with frontal sinus mucoceles.

The 80% success rate obtained in this study demonstrates the efficacy of frontal sinus drillout for the treatment of severe frontal sinus disease. The observed trend toward a higher long-term success rate for bilateral procedures is not unexpected as a larger opening is less likely to stenose. Weber et al similarly reported a higher success rate for Draf type III procedures vs type II, which are equivalent to bilateral and unilateral drillouts, re-
spective. It is interesting to note that in our study bilateral drillout failures occurred within 2 years of surgery, whereas failures following unilateral drillouts continued to be observed after 5 years.

The observed 20% failure rate for frontal drillout compared with approximately 10% for frontal sinus obliteration1 appears reasonable given the decreased morbidity of the an intranasal approach. Furthermore, the performance of a frontal drillout does not preclude additional surgical options should reobstruction of the frontal sinus occur. Patients in this study in whom frontal drillout failed were still able to undergo successful revision drillout or frontal obliteration surgery.

In a study of 20 patients who underwent endoscopic removal of the frontal sinus floor for chronic sinus disease, Gross et al14 reported a 95% success rate with a mean follow-up of 12 months. A similar short-term success rate of 86% was reported by Casiano and Livingston7 for 21 patients followed up for an average of 6.5 months after resection of the frontal sinus floor. Weber et al13 reported on a multicenter series where bilateral removal of the frontal sinus floor was performed in 156 patients with a success rate of 91.5% to 95%. This range reflects the variation in technique and definition of success among the different authors as well as the broad surgical indications, which included frontal sinusitis, trauma, and tumors.

In a report of 24 frontal drillout patients who were also included in the present study, Metson et al5 reported a success rate of 87.5% with a mean follow-up of 22.7 months. The lower success rate of 80% found in the present study probably reflects the longer follow-up period. Moreover, it is likely that a further decrease in the surgical success rate of frontal drillout surgery will be observed as these patients continue to be followed up over time.

Image guidance appears to be particularly useful in frontal drillout surgery where the surgeon is confronted with the complex anatomy of the frontal recess, the need to drill in proximity to the orbit and skull base, and the loss of anatomic landmarks associated with revision procedures. The fact that 35 patients were successfully operated without image guidance, however, indicates that the use of this technology is not imperative in frontal sinus drillout surgery. Furthermore, the comparable success rates in the image-guidance and non–image-guidance groups suggest that image guidance may not alter the overall long-term outcome of drillout surgery. Nevertheless, it is important to note that we currently perform all frontal drillout procedures with the assistance of an image-guidance system. The extent to which this system enhances the surgeon’s confidence, particularly when drilling in the vicinity of the orbit and skull base, cannot be overstated. Without an image-guidance system, initial drilling is “blind” until the frontal sinus is entered.

The complication rate was not significantly different between the image-guidance and non–image-guidance groups in this study. Because of the relatively low 4% incidence of complications associated with frontal sinus drillout, a much larger study population would be necessary to demonstrate any significant difference between groups.

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REFERENCES