



Endoscopic Repair of Anterior Table—Frontal Sinus Fractures

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Frontal sinus fractures account for 5% to 15% of all maxillofacial injuries [1]. The treatment algorithm for fractures involving the frontal recess or posterior table is complex because of the associated risks of brain injury, meningitis, cerebrospinal fluid fistula, and mucocele formation [2]. Mild-to-moderately displaced anterior table fractures, however, carry a low risk of long-term morbidity and generally are treated as aesthetic deformities. Traditional repair of isolated anterior table fractures requires a coronal incision, bony reduction, and rigid fixation. Surgical sequelae of this procedure include a large scar, alopecia, paresthesias, and uncommonly facial nerve injury. Consequently, some surgeons are starting to manage isolated anterior table fractures through an endoscopic approach.

General requirements for endoscopic surgery include: the ability to surgically obtain/maintain an optical cavity, insert a fiberoptic endoscope, sustain adequate hemostasis, and apply instrumentation [3]. At least two points of access generally are required. The advantages of endoscopic surgery include more accurate visualization, minimal external incisions, visualization around corners, reduced soft tissue dissection, reduced hospital stay, and improved teaching. Disadvantages include a moderate learning curve, narrow field of view, poor

depth perception, current lack of dedicated instrumentation, and the fact that the surgeon cannot operate bimanually without an assistant.

Endoscopic sinus surgery came to the United States in the late 1970s and became the standard of care in the 1980s. The indications for endoscopic head and neck surgery continue to expand. Current applications include otology (middle ear endoscopy), skull base surgery (pituitary, cerebral spinal fluid leak, optic nerve decompression), ophthalmology (dacryocystorhinostomy), facial plastic surgery (brow lift), neck surgery (thyroid, parathyroid, node biopsy), and facial trauma. Specific facial trauma applications include subcondylar, orbital, and frontal sinus fractures. This article reviews the indications and technique for endoscopic repair of anterior table frontal sinus fractures.

Indications

Not all isolated anterior table fractures are appropriate for this technique. Injuries with severe comminution and marked mucosal injury require open reduction or even frontal sinus obliteration. Fractures that extend over the orbital rim may be difficult or impossible to visualize endoscopically and may require an open approach. The ideal candi-

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dates for the endoscopic approach are reliable patients who have isolated anterior table fractures limited to the vertical face of the frontal bone.

Technique

Preoperative photographs and CT scans should be obtained to document the injury [Figs. 1, 2]. Informed consent is obtained for the procedure, including the risks of bleeding, infection, paresthesia, alopecia, poor aesthetic result, and possible need for open approach if an endoscopic repair cannot be performed. The patient's head is prepared and draped from the orbits to the vertex of the head. After injection of local anesthetic, a 3 to 5 cm parasagittal working incision is placed above the fracture and 3 cm behind the hair line [Fig. 3]. In patients with a prominent forehead or receding hair line, the incision may need to be closer to the hairline to allow visualization around the intrinsic curvature of the forehead. The incision length will vary depending on the size of the implant to be inserted. Care should be taken to avoid trauma to the hair follicles, and cautery should be avoided if possible. A second 1 to 2 cm endoscope incision then is placed at the same height, but 4 to 6 cm medial to the working incision [see Fig. 3]. A blind subperiosteal dissection is performed through the working incision down to the level of the fracture. Care should be used to maintain the integrity of the



Fig. 1. Anterior table frontal sinus fracture.

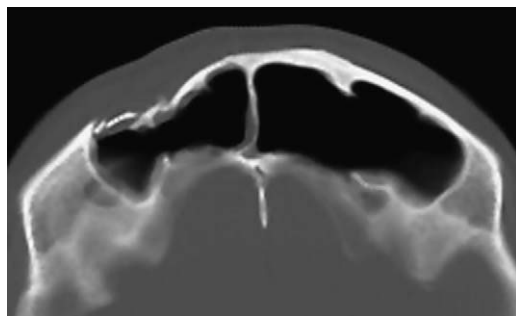


Fig. 2. Preoperative axial CT scan of patient in Fig. 1 demonstrating an anterior table frontal sinus fracture.

periosteum, because periosteal tears will catch the endoscope when it is inserted. A 4.0 mm, 30° endoscope (with rigid endosheath and camera) then is inserted through the smaller, medial incision, and the optical cavity is visualized. Dissection over the fracture is performed under direct vision to the level of the orbital rims. Caution must be used to avoid injury to the supratrochlear and supraorbital neurovascular pedicles. The elevation is generally easy, because the procedure is performed 3 months after the injury, and there is a fibrous layer preventing entry into the sinus.

Once the entire fracture is exposed, an implant is inserted to fill the defect. The authors have evaluated hydroxyapatite bone cement for this purpose but found it difficult to apply and manipulate endoscopically. A 0.85 mm thick Medpor (Porex Surgical - Newnan, Georgia) sheet is the preferred implant. The implant is trimmed to approximate the defect [Fig. 4]. The implant is inserted through the working incision and manipulated over the defect. The superior edge of the implant is marked with a pen to maintain the orientation endoscopi-

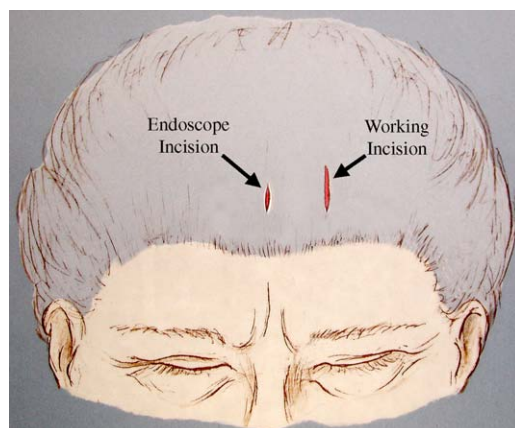


Fig. 3. Scalp incisions used for endoscopic repair of frontal sinus fractures.



Fig. 4. Intraoperative photograph of a 0.85 mm Medpor implant trimmed to camouflage the anterior table frontal sinus fracture.

cally [Fig. 5]. At times, the author has sutured two to three layers of Medpor together to fill the defect more accurately [Fig. 6]. A 25 gauge needle then is passed through the skin over the fracture site and endoscopically visualized to determine the best site for percutaneous screw placement [see Fig. 5]. The ideal site will allow placement of two screws at opposite edges of the implant. A #11 blade is used to make a 2 mm, through-and-through stab incision. A 1.7 mm self-drilling screw (length 4 to 7 mm) is passed through the stab incision, through the edge of the implant, and into the frontal bone. If the implant is not completely stable, a second screw is placed on the contralateral side. The self-drilling screw must be placed at least 0.5 to 1.0 mm away from the implant edge or the implant may tear. An alternative to the standard 0.85 mm Medpor sheeting is a prefabricated Medpor implant that is generated from a CT scan and completely fills the volume of the defect. The major advantage is a tight-fitting implant with little dead space. The dis-

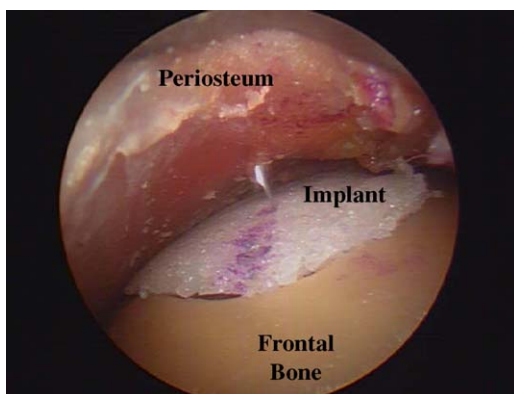


Fig. 5. Endoscopic view of Medpor sheeting inserted over a frontal sinus fracture. Note the 25 gauge needle being passed through the skin to localize the site of percutaneous screw placement, and the marking line on the superior aspect of the implant used for orientation.

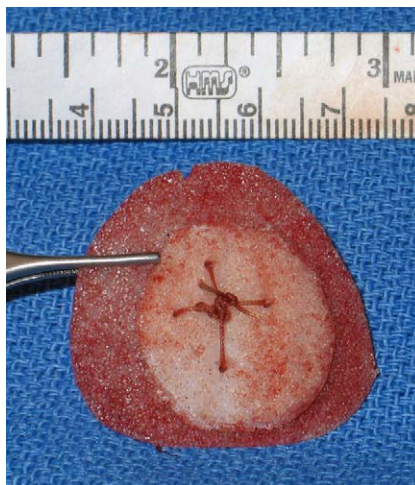


Fig. 6. Intraoperative photograph of a layered Medpor implant. Two 0.85 mm thick Medpor implants were sutured together to fill dead space in the anterior table defect.

advantage is that prefabricated implants cost approximately \$4000 and require 6 weeks for fabrication, as opposed to standard sheets which cost \$250 to \$450. Both types of implant are palpable through the skin, but are not visible upon inspection [Fig. 7]. After completion of the procedure,



Fig. 7. Postoperative photograph of endoscopically repaired anterior table frontal sinus fracture seen in Fig. 1.

the scalp incisions are closed in layers, and a head dressing is applied for 48 hours. No drains are used.

Discussion

Historically, almost all frontal sinus fractures were treated aggressively because of the long term risk of mucocele formation. Although the success rates for open reduction and internal fixation are very high, the procedure results in postsurgical stigmata, including a large scar, paresthesias, possible alopecia, and uncommonly facial nerve injury. Advances in endoscopic surgery and CT have provided more effective options for diagnosis and treatment of frontal sinus mucoceles. Consequently, more conservative endoscopic approaches are being investigated.

Several authors have described an endoscopic approach to frontal sinus fractures, eliminating the need for a coronal incision [4–6]. The endoscopic repair can be divided into two types: acute fracture reduction with or without fixation, and fracture camouflage. The fracture reduction technique involves exposure of the fracture in the acute setting, reduction of the bone fragments, and application of internal fixation as needed to maintain stability. This technique is covered elsewhere in this issue. The fracture camouflage technique involves an observation period to allow resolution of facial edema, followed by recontouring of the defect with an alloplastic implant.

Strong and colleagues compared the fracture reduction and camouflage techniques [3]. They found that both approaches were feasible. Fracture reduction, however, was technically more challenging, because it required mobilization and reduction of small bone fragments that may be under great compressive forces [Fig. 8]. If the interfragmentary resistance is too great, the reduction

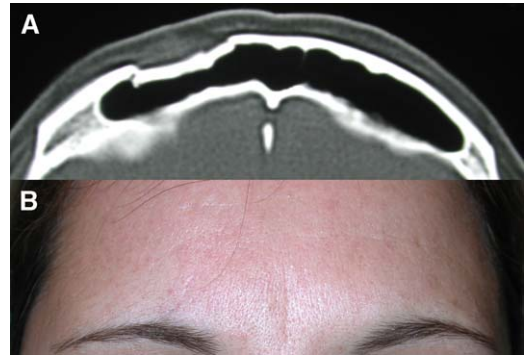


Fig. 9. (A) Coronal CT scan of a patient with an anterior table frontal sinus fracture with enough displacement to be considered for traditional open repair in the acute setting. (B) 4-month postinjury photograph of the same patient without any visible cosmetic deformity. The patient received no treatment for the injury.

cannot be performed. If the interfragmentary resistance is too little, it may be difficult to maintain the reduction, because the bone fragments are free floating. The fracture camouflage technique was found to have several advantages:

- The exposure is easier, because the bone fragments are not mobile.
- The repair is technically less challenging, because it does not require manipulation of bone fragments.
- The repair need not be done in the acute setting.

Delayed repair can be important, because once the soft tissue edema resolves, there may be no esthetic deformity, and the patient may not require any surgical intervention. This determination, however, cannot be made until 3 to 4 months after the injury. Using the camouflage approach, only those patients with a true aesthetic deformity will require surgery [Fig. 9]. The main disadvantage of

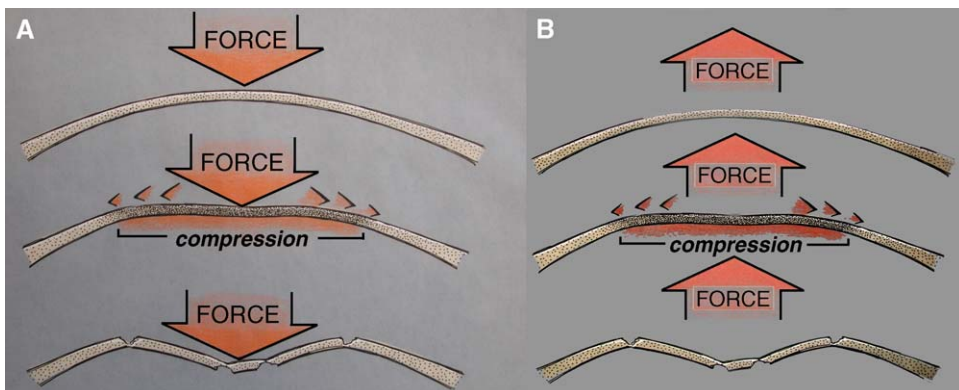


Fig. 8. External forces applied to the frontal bone during (A) fracture and (B) surgical repair.

the camouflage technique is the need for an alloplastic implant. The authors currently use the camouflage technique with 0.85 mm thick Medpor sheeting to treat isolated, moderate displacement (2 to 6 mm) fractures of the anterior table. Medpor has a long track record for maxillofacial reconstruction. It is relatively cheap, easy to handle and insert, and well-tolerated. Additionally, it can be removed in one piece should it be necessary.

Summary

Endoscopic repair (ie, camouflage) of anterior table frontal sinus fractures is an efficacious technique that significantly reduces patient morbidity. It also has the added advantage of being a secondary procedure. Therefore, only those patients with a true aesthetic deformity require surgery. Surgeons considering this technique should be very comfortable with endoscopic equipment and techniques. The skill set is very similar to that of an endoscopic brow lift. Prefabricated implants can be used, but

standardized sheeting is equally effective and significantly cheaper.

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