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Endoscopic Management of Frontal Sinus Fractures

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Management of facial trauma always has been a balancing act between achieving accurate fracture reduction and stabilization, while causing as little morbidity as possible. Until roughly the 1930s, management of facial fractures consisted of external splints and bandages, which simply immobilized the fractures and allowed them to heal. Although external splints imparted little morbidity, the fractures rarely were reduced anatomically. Later, interfragment wires and suspension wires were developed, somewhat improving reduction and stabilization. Wire placement and fracture reduction, however, required multiple small keyhole incisions, and the reductions rarely were completely accurate or rigidly stabilized. In the late 1980s and early 1990s, the development of plate and screw fixation placed by means of extended-access approaches provided excellent fracture reduction and fixation but required long incisions and extensive soft tissue elevation [1–16]. As surgeons continued to refine their management of facial trauma, it was only natural that a less invasive approach to fractures would be found.

Endoscopes have had a profound effect on nearly every surgical specialty over the past 20 years. Using endoscopic approaches, excellent visualization of the surgical site can be achieved while avoiding extensive external incisions, thus, dramatically reducing morbidity compared with traditional surgical approaches. The specialties of orthopedics, gynecology, abdominal surgery, thoracic surgery, and paranasal sinus surgery have been enhanced by the ability to perform accurate endoscopic surgery while virtually eliminating the long surgical scars and pain of surgical approaches. To perform effective endoscopic surgery, a cavity is required to keep soft tissue from draping over the endoscope and obscuring visualization of the surgical site. The use of endoscopes for facial surgery has lagged behind these other specialties primarily because of the lack of a readily usable optical cavity, but also difficulty working around the curve of the skull. In the aforementioned surgical specialties, the optical cavities are either natural (as with sinus and thoracic surgery) or created by infusing gas (abdominal surgery) or saline (orthopedic surgery). Unfortunately, for most facial skeletal surgery, there is no readily available cavity in which an endoscope can function. To overcome this deficiency, special sheaths have been designed for the scopes with extensions that hold soft tissue away from the surgical site. Typically, a 30° scope is used in conjunction with the sheath and extension. These tent the soft tissues away from the surgical site. This tenting of the soft

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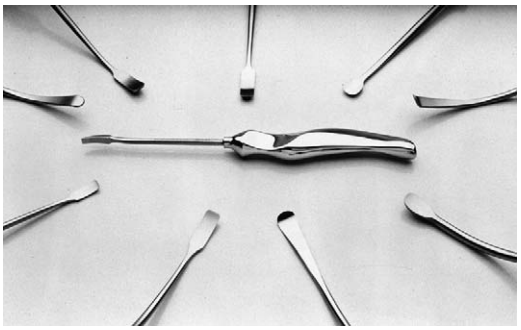

Fig. 1. Various endoscopic instruments.

tissue creates an optical cavity, allowing the surgeon to look down on the surgical site using a 30° scope. [Figs. 1–4]. This article outlines the state of the art with regard to the use of endoscopes for managing frontal sinus fractures, which are one of the most common fractures treated with endoscopic techniques.

Endoscopic management of frontal sinus fractures

Endoscopic forehead lifting has been accepted for the past 10 years and has provided significant experience with endoscopic management of the frontal region for aesthetic purposes [17–23]. With this experience has come well-developed exposures and instrumentation. Using endoscopic techniques, several authors have reported case reports detailing successful management of anterior wall fractures of the frontal sinus [24–29]. These reports have dealt exclusively with eggshell fractures of the anterior wall that simply are popped back into position and allowed to heal without fixation. Strong and colleagues reported on a cadaver study looking at the feasibility of performing endoscopic reduction and fixation. They found that the fractures could be visualized, but they encountered difficulty with complete reduction and were unable to perform rigid fixation in a noninvasive manner. As an alternative, Stronge and colleagues recommended camouflaging the anterior wall depression by endoscopically applying hydroxyapatite bone cement.

Fig. 3. Endoscopic sheath.

At the University of Cincinnati, the author and colleagues have attempted endoscopic reduction of frontal sinus fractures on 19 patients and have been successful in 12 of them. Success is defined as a reduction sufficiently anatomic and stable that no further treatment was felt to be necessary (by the physician or patient) The author's technique is similar to endoscopic forehead lifting, with one central and two lateral hairline incisions [Figs. 4 and 5]. It is preferred to work through separate ports for the endoscope and instruments to avoid crowding of the instruments and scope at the anterior portion of the incision. The forehead soft tissues are elevated subperiosteally, and the fractures are visualized by means of a 30° endoscope with an external sheath for soft tissue retraction [Figs. 6 and 7]. Once the fracture site is visualized, one attempts to elevate the fragments with endoscopic elevators. The author, however, has found that it is usually necessary to approach the fragments directly through small forehead incisions (preferably hidden in the brow). Using small external incisions directly over the fractures allows the surgeon to apply anterior force for anatomic reduction of the fracture segments. This approach has been more successful than trying to work within the forehead skin envelope, which requires more of a prying motion to elevate the fractures; this tips the fragments. The fractures are elevated using percutaneous nerve hooks, or by drilling into the fragments and grabbing them with threaded Stein-

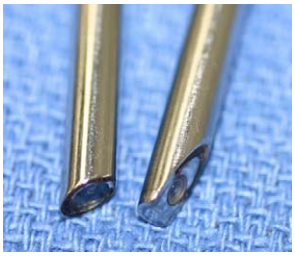

Fig. 2. 30° and 70° scopes. Most frequently the 30° scope is used.

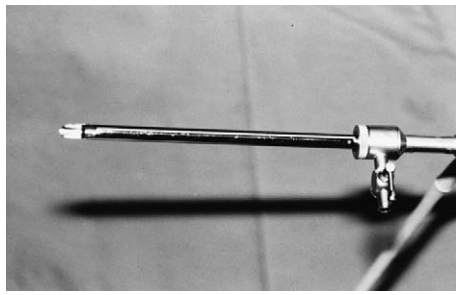

Fig. 4. Endoscope inside endoscopic sheath.

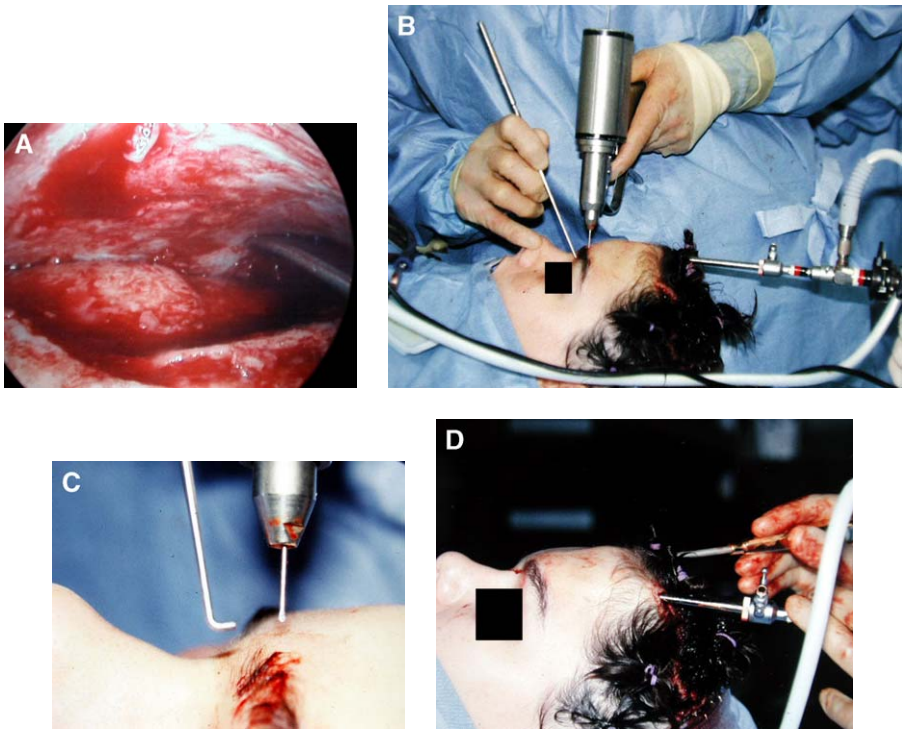

Fig. 5. (*A*) Endoscopic view of frontal sinus anterior wall fracture. (*B*) Direct percutaneous approach with threaded Steinman pin and nerve hook to elevate bone fragments. (*C*) Combination of nerve hook and threaded Steinman. (*D*) Instruments in midline and paramedian incisions.

mann pins [see Figs. 5–7]. With gentle retraction, the fragments often elevate into a reduced position and are frequently stable without the need for rigid fixation. Given the fact that the fracture segments are not approached directly, it is common to have residual surface irregularities. These irregularities are considered a trade off for avoiding long, approach incisions, and they are camouflaged with patches of Vicril Mesh (Ethicon, Inc., Somerville, New Jersey) [Fig. 7].

Fig. 6. The surgeon sits at the head of the table, and the monitor is at the foot.

In the four patients whose endoscopic fracture repair was felt to be unsuccessful, the reason was that the fracture segments were unstable after endoscopic reduction. The fragments continued to collapse despite having been reduced. In retrospect, these unsuccessful reductions were more extensively comminuted then was appreciated on the initial review of the coronal and axial CT scans. This highlights the importance of careful patient selection and the need for fully informing patients that the endoscopic approach may not reduce their fractures fully. Cases with unstable anterior walls after endoscopic reduction were converted to an open approach with coronal incisions and rigid fixation in the standard fashion [Fig. 8]. Based on this experience, the author feels that the endoscopic technique is appropriate only for anterior wall frontal sinus fractures that have several large segments without extensive comminution. It goes without saying that more extensive fractures with involvement of the nasofrontal ducts or posterior wall should have open approaches . Additionally, the surgeon should be prepared to camouflage any residual irregularities with the material of choice. As mentioned, the author prefers Vicril mesh, but alternatives would include bone cement, Gore-Tex, Alloderm, or Surgicell.

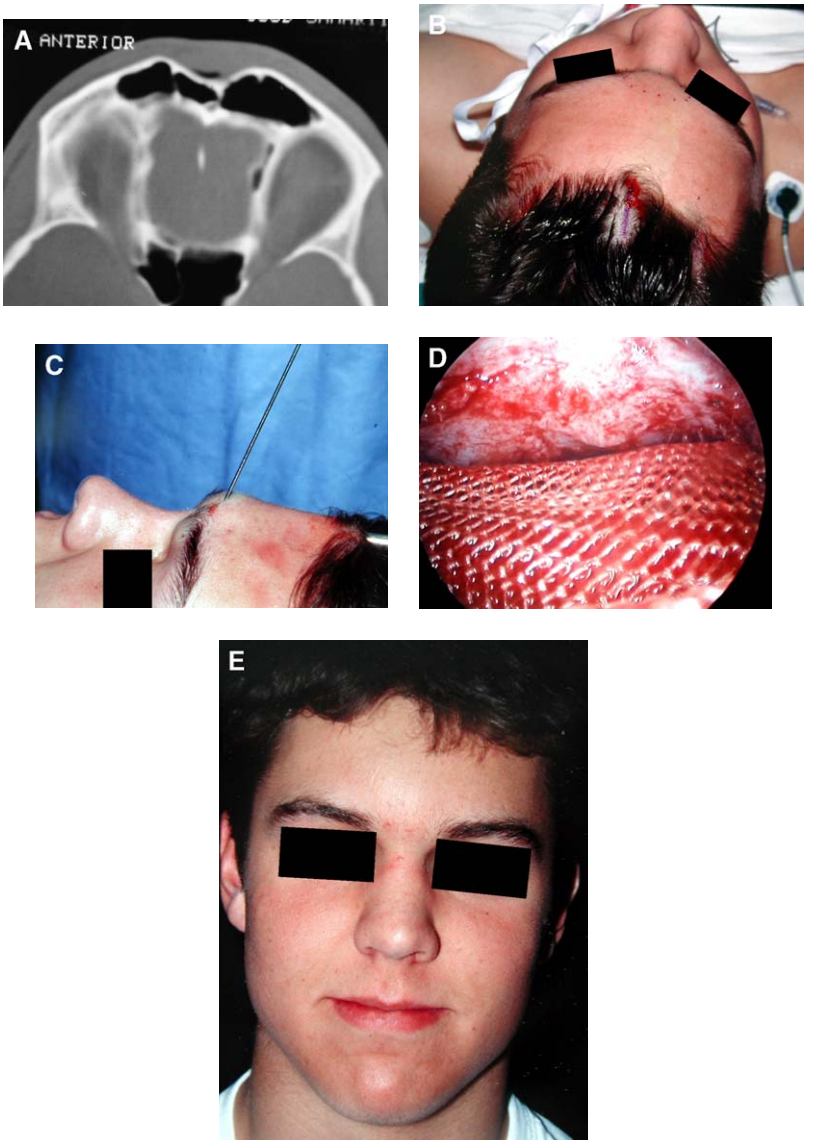

Fig. 7. (*A*) Frontal sinus anterior wall fracture. This is a good candidate for endoscopic reduction, because it is not comminuted. (*B*) Incisions planned. (*C*) Threaded Steinman pin used to reduce fracture fragments while the endoscope is used to monitor the reduction. (*D*) Endoscopic view of Vicryl mesh placement for camouflage of residual irregularities. (*E*) Six-week postreduction photo.

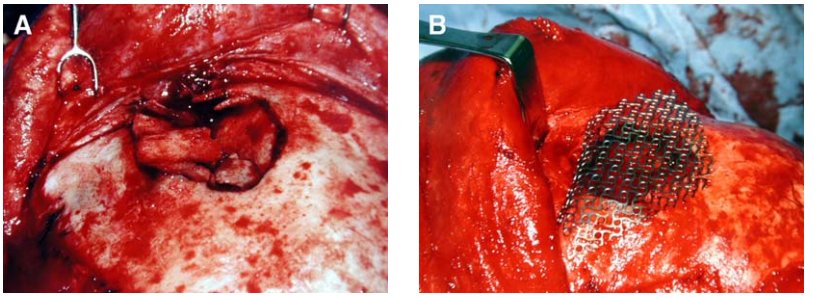

Fig. 8. (*A*) Unsuccessful attempt at endoscopic reduction. The fracture was too comminuted and unstable. (*B*) Fracture was managed with a coronal approach and rigid fixation with titanium mesh.

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