Management of a type II nasoethmoid orbital fracture and near-penetration of the intracranial cavity with transnasal canthopexy

Philip A. Young, MD; Dale H. Rice, MD

Abstract

Nasoethmoid orbital fractures are perhaps the most complicated aspect of craniomaxillofacial trauma. Involvement of the medial canthal tendon markedly increases the complexity of the repair. We report a case of type II nasoethmoid orbital fracture in a 32-year-old man that was managed without formal medial canthal tendon repair; instead, we used open reduction and internal fixation of the central fragment and the nasoethmoid complex. However, during the immediate postoperative period, we noted anterior and inferior displacement of the medial canthus. We took the patient back to the operating room to address the detachment. Revision surgery was successful, and at the 6-month follow-up, his medial canthi were completely symmetrical in all dimensions. We describe our intraoperative technique and measures to prevent complications that can help the surgeon intraoperatively. We also discuss an important point that has not been adequately addressed in the literature to date—that is, the fact that the use of the frontoethmoid suture line and the anterior ethmoid artery as a guide to the skull base can be inaccurate. Problems associated with this inaccuracy can be avoided by carefully reviewing preoperative computed tomography, which can help keep the surgeon from entering the intracranial cavity while fixing the medial canthal tendon during transnasal canthal repair.

Introduction

A nasoethmoid orbital fracture is one of the most difficult fractures for the craniomaxillofacial plastic and reconstructive surgeon to treat. Situated in the upper and central part of the middle third of the face, this type of fracture lies at the nasal, orbital, cranial, and frontal sinus junction. Involvement of any of these areas can add to the complexity of the fracture repair. The nasal area is the weakest portion of the facial skeleton. As force exerted against the nasal dorsum and root of the nose increases, the resulting trauma progresses from a simple septal fracture to involvement of the nasal bones. With more force, the fracture progresses to involve the thick glabellar bone, the frontal sinuses, and the medial and inferior orbital rims. Even more force results in involvement of the cribriform plate and the lamina papyracea, which provide relatively little resistance.

The treatment of nasoethmoid orbital fractures has progressed from closed reduction and secondary treatment, which often led to poor results, to primary open reduction and fixation with plates and screws, which is now the gold standard. The status of the medial canthal tendon and the central fragment is crucial to the diagnosis and treatment of nasoethmoid orbital fractures. Managing the medial canthal tendon markedly increases the complexity of a nasoethmoid orbital repair. Treatment of the medial canthal tendon has evolved from closed reduction, use of external bolsters, interfragment wiring, and tendon suturing to transnasal canthopexy. Canthopexy requires that the surgeon pay meticulous attention to attaching the tendon to the posterior and superior portions of the lacrimal fossa, as described by Markowitz et al and others.

A number of classification schemes for nasoethmoid orbital fractures have been introduced, but the one developed by Markowitz et al is perhaps the best known and most
referred. They classified nasoethmoid orbital fractures into three types:

- A type I fracture is characterized by the presence of a large, noncomminuted central fragment.
- A type II fracture is a comminuted fracture in which both the central fragment of bone and the insertion of the medial canthal tendon are intact.
- A type III fracture is a comminuted fracture in which the fracture lines violate the central segment and markedly weaken the stability of the medial canthal tendon.

Transnasal canthopexy has probably become the gold standard for medial canthal tendon repair in nasoethmoid orbital fractures. However, if the central fragment has little bone left to which a plate can be sufficiently applied, we prefer detachment of the medial canthal tendon with refixation, using the combination of transnasal wiring and miniplates (interfragment wiring is less than ideal in such a situation). This can be accomplished without increasing the thickness of the nasal root, which some have suggested is a drawback to using miniplates. An important consideration is that in some cases, even a minimal amount of dissection of the central fragment performed to accommodate a single microplate hole and screw is enough to weaken the medial canthal tendon to the point that it cannot support the medial canthus and the lower eyelid structures; even with transnasal wiring of the fragment, as suggested by Markowitz, the tendon would be too unstable to provide proper support. Despite proper bony reduction of the central fragment, the soft tissues and the medial canthal tendon can be lax, leading to a cosmetic deformity or a less-than-ideal result. When in doubt, the medial canthus can be adequately repaired by (1) a full detachment of the medial canthal tendon with transnasal wiring, (2) wiring to a miniplate in proper position, or (3) a combination of the two, depending on the stability of the bone fragments.

Insufficient attention has been paid to the fact that the frontoethmoid suture line and the anterior ethmoid artery are not always an accurate guide to the skull base during transnasal canthopexy; at most, this problem has been mentioned only in passing in many literature reports and well-known textbooks. Some authors have paid little or no attention to the close association of the cribriform plate with the lacrimal fossa, anterior ethmoid artery foramina, and the frontoethmoid suture line. This inaccuracy can become a serious problem during transnasal canthopexy because the wire has the potential to come very near to the junction of the cribiform plate and the nasal cavity after it has been moved through the posterior and superior aspects of the lacrimal fossa. Obviously, the presence of a foreign body in the intracranial cavity can result in disastrous complications, including intracranial penetration. We emphasize that complications can be avoided by studying a computed tomography (CT) scan preoperatively and relating the frontoethmoid suture line or the anterior ethmoid artery within the surgical anatomy intraoperatively.

Case report
A 32-year-old man presented to us in the emergency department after he had been struck in the face by a tree branch. He was alert and oriented, and he exhibited no diplopia, epiphora, rhinorrhea, or epistaxis. On examination, we noted an obvious depression at the nasal root and associated ecchymosis. Gross telecanthus was not appreciated amid the significant swelling. The bowstring test revealed that the medial canthal tendon was intact, and we noted no rounding of the canthus. The palpebral aperture was normal on both sides. Extraocular movements were not restricted. Subconjunctival hemorrhage was present, more so on the left side. A palpable step-off was noted at the glabella, the nasal root, and the inferior orbital rim on the left side.

CT detected a nasoethmoid orbital fracture that appeared to primarily involve the left complex (figure 1, A). CT also showed that the foramen of the anterior ethmoid artery traversed the superior nasal cavity in its own mesentery, as seen in the patient’s right superior nasal cavity (figure 1, B). The anterior ethmoid artery was located just posterior to the posterior wall of the frontal sinus as expected. The level of the artery was 3 to 4 mm above the cribriform plate. The primary involvement of the left side was confirmed intraoperatively (figure 2, A). Intraoperative examination also confirmed the CT findings that the anterior table of the frontal sinus, the inferior orbital wall, and the medial orbital wall were all fractured. The fractures were plated with mini- and microplates (figure 2, B).

The medial canthal tendon appeared to be attached to a small, single central fragment, and there was no fracture line through the segment. Based on these findings, we diagnosed the trauma as a Markowitz type II fracture. While attempting to plate the central piece, we discovered that there was not enough room to place a plate with a single microscrew. Therefore, with minimal undermining, a plate was adapted to the central fragment, and the canthus appeared to be intact. Because the anatomic reduction appeared to preserve the intercanthal distance and the fractured segments, and given the preoperative stability of the medial canthus bilaterally, we felt that the medial canthus did not require a formal transnasal canthopexy. An intraoperative bowstring test confirmed that the canthus was relatively intact.

Postoperatively, we noted that the medial canthus was inferiorly and anteriorly displaced. After some lengthy consultation, the patient felt that the displacement was significant enough to warrant correction, and the next day we took him back to the operating room.

After exposure via our original coronal incision, we
used a full-thickness nylon suture with needle to identify the medial canthal tendon. We observed that a significant portion of the medial canthal tendon insertion was located at the site that we had dissected to place the plate and one microscrew. The residual attachment was not strong enough to adequately support the lower lid structures. Therefore, we dissected the rest of the ligament free from the plated central fragment and then placed another microplate deeper within the orbit extending from the nasal root. This microplate was then used to attach our transnasal wire in a posterior and superior relation to the lacrimal fossa. Relating the position of the posterior lacrimal crest with the uninvolved side, we then took a hand drill with a 1.5-mm drill bit and fashioned a through-and-through tunnel that exited near the superior portion of the lacrimal fossa on the contralateral side.

We attempted to trace the frontoethmoid suture line and the anterior ethmoid artery in the involved orbit, while also correlating with the other side, in order to be sure that the direction of our drilling was inferior to the anterior skull base and the cribriform plate, given our knowledge that these are anecdotally reliable markers. We placed a second microscrew superiorly and medially just within the orbit on the uninvolved side to serve as an anchor. We placed the screw on the thick glabellar bone and were careful not to penetrate the frontal sinus. We attached the medial canthal tendon to 26-gauge steel-wire sutures and threaded them through a spinal needle to the other side. The presence of our previously placed through-and-through black nylon sutures allowed us to accurately locate the medial canthal tendon. We then tightened the wire around the screw in the contralateral orbit until the canthus was restored in the posterior and superior position relative to the lacrimal fossa. Externally, we retested the medial canthus and found that it was completely immobile and solid against the miniplate.

A postoperative CT was ordered to evaluate frontal sinus drainage. Coronal CT demonstrated the proximity of the steel wire to the inferior aspect of the cribriform plate (figure 3, A). Although the wire did not appear to penetrate the intracranial cavity, its proximity to the cribriform plate engendered significant attention. Axial CT showed that the crista galli was along the same coronal plane as the wire and, again, the wire appeared to come very close to the skull base (figure 3, B).

The patient experienced no postoperative complications. At the 6-month follow-up, his medial canthi were completely symmetrical in all dimensions (he refused to submit to postoperative photography).

Discussion
The literature on the use of the frontoethmoid suture line and the anterior ethmoid artery as markers for the skull...
base is limited. Most of the published information on the cribriform plate is found in articles about the surrounding sinus anatomy. Stamm and Pignatari described the relationship of these structures thusly: “The frontoethmoidal suture is located at the level of the roof of the nasal cavity and the cribriform plate. . . . [T]he anterior and posterior ethmoidal arteries and nerves . . . are located in, or just above, the frontal ethmoidal suture. These arteries and nerves exit the ethmoidal foramina and enter the anterior cranial fossa at the lateral edge of the cribriform plate.”

Our case serves to point out that the relationship of (1) the level of the frontoethmoid suture line and the anterior ethmoid artery to (2) the cribriform plate and the intracranial cavity is variable. As mentioned earlier, our patient’s preoperative coronal CT clearly demonstrated that the foramen of the anterior ethmoid artery traversed the superior nasal cavity in its own mesentery. Its location was just posterior to the posterior wall of the frontal sinus as expected, but the level of the artery was 3 to 4 mm above the cribriform plate. Therefore, using only the frontoethmoid suture line or the anterior ethmoid artery as a guide to the skull base might have been disastrous in this case. During our intraoperative assessment, we used the contralateral medial canthus along with the anterior and posterior lacrimal crests, the frontoethmoid suture line, and the anterior ethmoid artery as our guide to the correct placement of our new canthus, thereby following commonly accepted techniques for transnasal canthopexy. We directed our drilling from a position posterior and superior to the lacrimal fossa on the involved side to the superior portion of the lacrimal fossa between the anterior and posterior lacrimal crests on the contralateral side, while noting the level of the anterior ethmoid artery. Even so, however, we found that our wire was dangerously close to the skull base.

Based on this case, we believe that the relationship of the frontoethmoid suture line, the anterior ethmoid artery, and the cribriform plate requires additional investigation before surgeons can use these structures as reliable markers during surgery. CT evidence is essential for each particular patient studied, because reliance only on statistics is subject to the impreciseness of ranges and standards of deviation.

We believe that a central, intact fragment that cannot accommodate the placement of a single microplate and screw is essentially a Markowitz type III fracture that most likely will require transnasal canthopexy with canthal detachment. Our case required full detachment and transnasal canthopexy with steel wire sutures to reconstruct the tendon.

We also propose that type II fractures be subclassified thusly:

- A type IIA nasoethmoid orbital fracture would be characterized by the presence of a central fragment that could accommodate plates and screws without exposing and destabilizing the medial canthal tendon. Reduction of the fragment into anatomic position with the intercanthal distance being preserved with plates and screws should be adequate and should obviate the need for transnasal canthopexy of the central fragment. Ideally, two-point fixation is the goal, but a single screw and plate can suffice.
- In a type IIB fracture, the central fragment would be too small to accommodate a single plate. Any exposure to facilitate incorporation of a single plate would destabilize the medial canthal tendon and essentially render it unable to support the lower lid structures and the medial canthus. The medial canthal tendon would require full detachment with transnasal canthopexy to accurately restore the medial canthus.

A destabilized medial canthal tendon cannot be returned to its preinjury state by stabilizing the central fragment. When the strength of the medial canthal tendon is in

Continued on page 360