

Pearls of Nasoorbitoethmoid Trauma Management

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ABSTRACT

Nasoorbitoethmoid fractures account for ~5% of adult and 15% of pediatric facial fractures. The appropriate management of these injuries requires an understanding of the anatomic features of the region, the classification of injury severity, assessment, and treatment methods. The purpose of this article is to provide a general overview of the topic, with a more specific focus on the pearls of managing these fractures. Prompt and proper management of these injuries can achieve both adequate functional and aesthetic outcomes.

KEYWORDS: Nasoorbitoethmoid fractures, NOE fractures, facial trauma, nasolacrimal duct, epiphora, medial canthal tendon, central fragment

Nasoorbitoethmoid (NOE) fractures present some of the most challenging scenarios in facial fracture reconstruction. However, they are increasingly uncommon as airbags have significantly reduced the incidence of facial fractures and panfacial fractures after motor vehicle accidents.¹ In our recent experience, NOE fractures occur in ~5% of all adult facial fractures.² Within the pediatric population, NOE fractures are more common, with studies finding that they account for roughly 16% of facial fractures.³

Despite their overall reduced incidence, understanding the management of these injuries remains important. Suboptimal initial management routinely results in very poor results and late complications, including shortened palpebral fissures, telecanthus, enophthalmos, dystopia, and saddle nasal deformity, which are almost impossible to fully treat secondarily. Improper attention to concomitant injuries can also lead to significant sequelae, as close to 60% of NOE fractures are associated with orbitozygomatic fractures and ~20% are seen in the setting of panfacial fractures.⁴ Despite the

need to act quickly, properly, and in a thorough fashion, optimal outcomes are obtainable.

ANATOMY AND CLASSIFICATION

The NOE region is formed by the confluence of several bony structures from the upper facial skeletal, midface, cranium, nasal, and orbital regions. Understanding the pertinent anatomy requires a familiarity with several key structures. The medial canthal tendon (MCT) splits before inserting into the frontal process of the maxilla. These two limbs of the tendon surround the lacrimal fossa. This critical central component to the NOE is surrounded posteriorly by the lacrimal bone, anteriorly by the nasal bones and pyriform aperture, cranially by the frontal bone, inferiorly by the maxilla, medially by the ethmoid air cells, and laterally by the orbit and its contents.

The most common system used for grading injuries to this region is the Markowitz and Manson classification scheme, which grades the extent of damage

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Figure 1 (A, B) Bilateral class I fractures of the NOE region as demonstrated by axial and coronal CT scans. Note the relatively large and intact portion of the frontal process of the maxilla or “central fragment.”

based on the status of the central fragment and MCT.⁵ In class I injuries, the tendon is attached to a relatively large “central fragment” of fractured bone (Fig. 1). In class II injuries, the tendon is attached to more comminuted fragments of bone that are difficult to manipulate at the time of reduction. Class III fractures involve avulsion of the MCT from its bony insertion. The vast majority of NOE injuries are class I injuries, whereas class II and III injuries occur much less frequently. Class III injuries are the rarest and account for roughly 1 to 5% of all NOE fractures.⁴⁻⁶ These avulsions of the MCT tend to be the most severe and are associated with high-energy injuries.⁷

DIAGNOSIS

As with any craniofacial injury, priority needs to be given to advanced trauma life support (ATLS) guidelines and the ocular exam, particularly with respect to traumatic optic neuropathy. With respect to the physical exam of the area, NOE injuries are typically massively swollen, precluding appreciation of any but the most obvious local findings. The most important factor in determining the treatment plan for a NOE injury is stability of the bone to which the MCT attaches. With mobile NOE fractures or avulsion of the MCT, lateral tension on the lower eyelid typically results in some degree of mobility in the region of the MCT. This should be directly palpated. Epiphora, or excess tearing, is associated with nearly half of these injuries,⁸ and can be secondary to either lacrimal duct injury, obstruction by bone fragments, or soft tissue swelling. Persistent nasolacrimal tract obstruction, however, only occurs in ~5 to 10% of cases.^{5,8} Primary exploration of this is never indicated unless it is clearly lacerated.

A significant portion of these injuries will also present with a substantial loss of nasal support. The nasal

dorsum is often affected because of the coexisting damage to the cartilaginous and bony nasal septum, upper and lower cartilages, nasal bones, and nasomaxillary buttress (Fig. 2).⁹ This can result in collapse of the nasal dorsum. Studies would indicate that dorsal nasal bone grafting is required in up to 40% of these injuries.⁴⁻⁶ One can test for loss of nasal support by simply applying digital pressure to the nasal dorsum and checking for stability. Although nasal tip support can also be affected, this occurs less frequently, with only 5 to 20% of fractures requiring a columellar strut graft.^{5,6}

Much of the information guiding surgical management is determined from the computed tomography (CT) scan findings. One must critically examine the bone segment to which the MCT is attached. Anatomically, this tendon splits and inserts on either side of the lacrimal fossa. On the scan, this is represented as an indentation in the region of the anterior aspect of the medial orbital wall. In the presence of a severe fracture, it may be difficult to find this area. Using axial cuts, it is helpful to follow the lacrimal canal as it ascends to this area. For a true NOE fracture to be present, this bone must be fractured.⁶ It is also important to carefully examine the region of the orbit, particularly looking for medial orbital wall involvement, as this may require bone grafting to restore orbital volume and facilitate transnasal canthopexy. Attention should also be directed to the status of the nasal bones to determine the need for additional support. Finally, the frontal sinus is also often an issue and should be carefully evaluated radiographically.

TREATMENT

The general goals of treatment are to restore the normal appearance of the eyes and nose. To do this, one must address several key features, including the intercanthal distance, symmetry and stability of the nasal sidewalls,

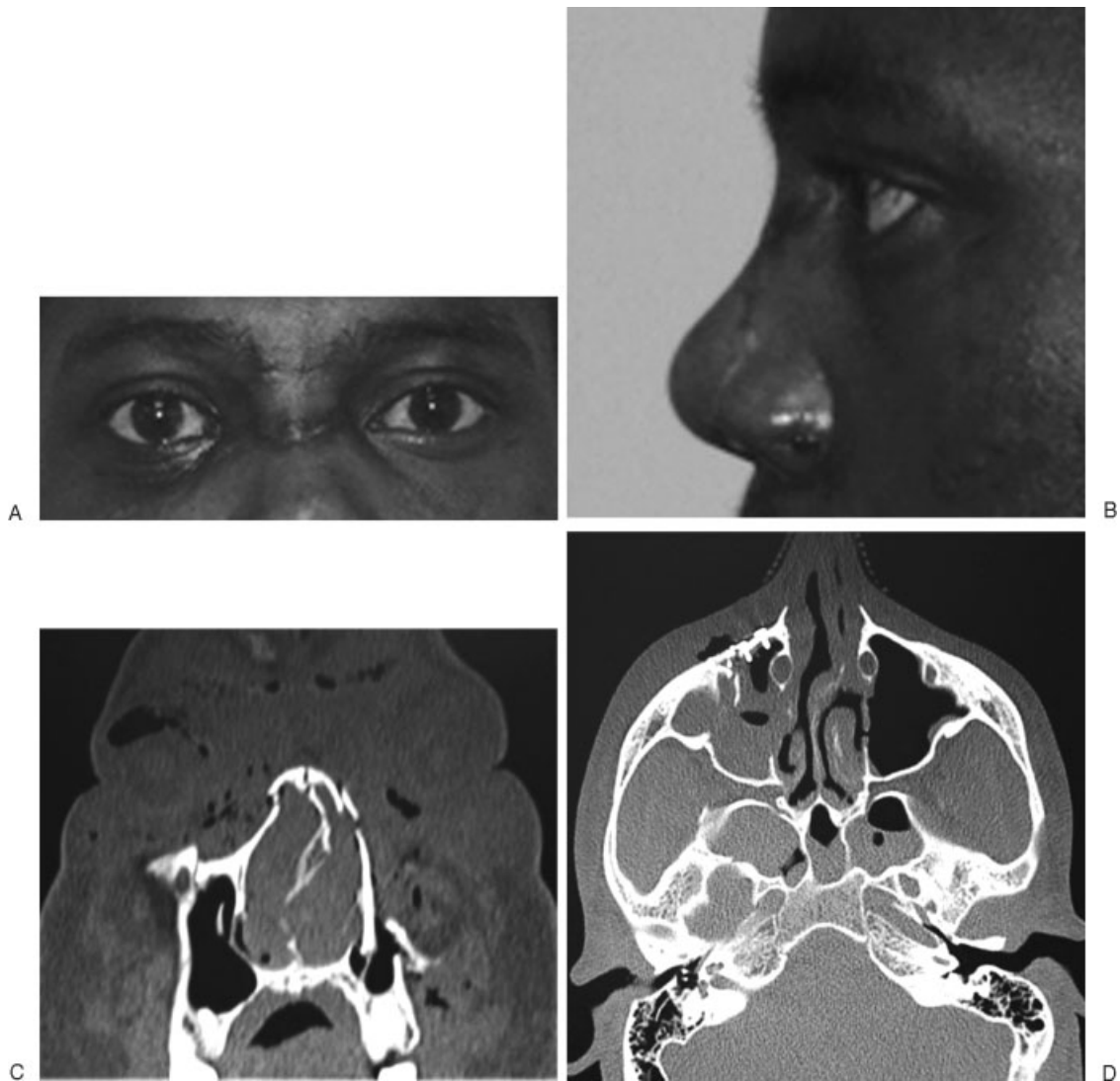


Figure 2 (A–D) Providing nasal dorsal support is necessary in a significant portion of cases because of damage to structures that normally support the dorsum. These structures include the nasal septum, nasal bones, and the maxilla, among others.

and nasal projection and contour. Occasionally, based on exam and CT findings, there may still be some doubt as to whether or not the fracture requires intervention. If the patient is to be brought to the operating room for other fractures, one may better assess the need for operative fixation by taking a blunt elevator and placing it intranasally on the medial aspect of the lacrimal fossa. With digital manipulation externally and pressure on the blunt elevator, one can assess the mobility of the area.⁷ Nonmobile class I injuries can be managed nonoperatively.

Once it is decided that a fracture requires surgery, full exposure of the region is mandatory. Generally speaking, NOE reduction and fixation requires a coronal incision (for the superior NOE region) plus a lower-eyelid incision (for the inferior NOE region or orbital walls) (Fig. 3).¹⁰ The lower-lid incision is best performed transconjunctivally and can be extended to a

transcaruncular incision if necessary. When visualizing the NOE region and radix, it may be helpful to score the periosteum of the soft tissue envelope to expand this area and better improve visualization. The orbit should be completely degloved; however, care should be taken not to strip the soft tissue attachments off of the central fragment. If one is having difficulty in finding the central fragment, one should use the nasofrontal suture. The nasofrontal suture marks the barrier between the intracranial and extracranial space. If one follows this posteriorly and inferiorly from the region of the radix, it should lead to the apex of the lacrimal groove. This is very helpful in identifying the central fragment. Tugging on the lower lid to demonstrate motility is also helpful.

Once the region is fully exposed, the decision must be made as to whether or not the bone fragment containing the MCT is large enough to support direct plating. This is obviously the most expeditious route in

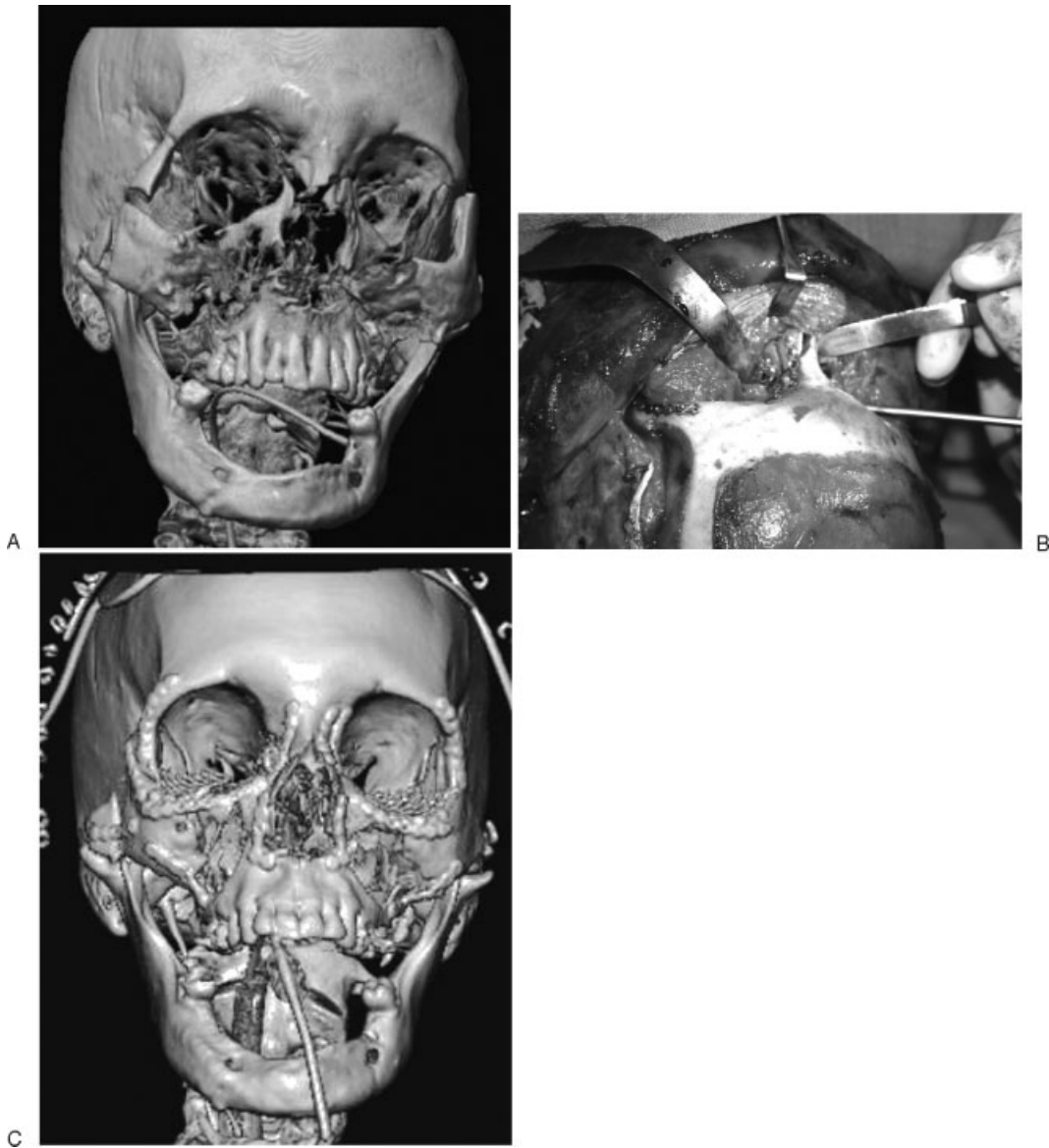


Figure 3 (A) Bilateral class 1 fractures that required fixation. (B) The coronal approach provides access to fixate the superior portion of the NOE region, and the lower eyelid or gingivobuccal incision allows for fixation of the inferior portion. (C) Concomitant orbital floor reconstruction is often necessary in these patients given the proximity of the floor and involvement of the inferomedial wall of the orbit.

treating these fractures. If a large bone fragment is present, it should be anatomically reduced bimanually and stabilized with small plates (class I). If it is not a large enough fragment to directly stabilize (class II), or if the tendon is simply avulsed (class III), a transnasal canthopexy is necessary. The most crucial aspect in performing a transnasal canthopexy is getting the correct vector of pull on this canthal tendon. The vector of pull needs to be posterior enough to reorient the tendon. Generally speaking, the proper point of insertion is just posterior to the upper portion of the lacrimal fossa. To secure the tendon itself, one may either take a bite of the medial canthal area from the posterior aspect of the coronal flap or one may directly loop it. The senior

author's preference is directly looping the tendon itself. This is done by performing an incision just into the dermis over the side of the MCT, approximately 3 mm medial to the medial canthus. At this point, the lacrimal canaliculus dives deep and should not be at risk from the suture. A double-armed suture or a suture with a free needle is used to place the stitch on either side of the lacrimal tendon. This is then grasped from the deep side of the coronal incision. This ensures that the MCT has been completely grasped. It is preferable in these situations to use a noncolored permanent suture. To prepare a point of attachment there are many techniques that have been tried. One useful technique is to use a wire-passing bit and drill from this contralateral side of

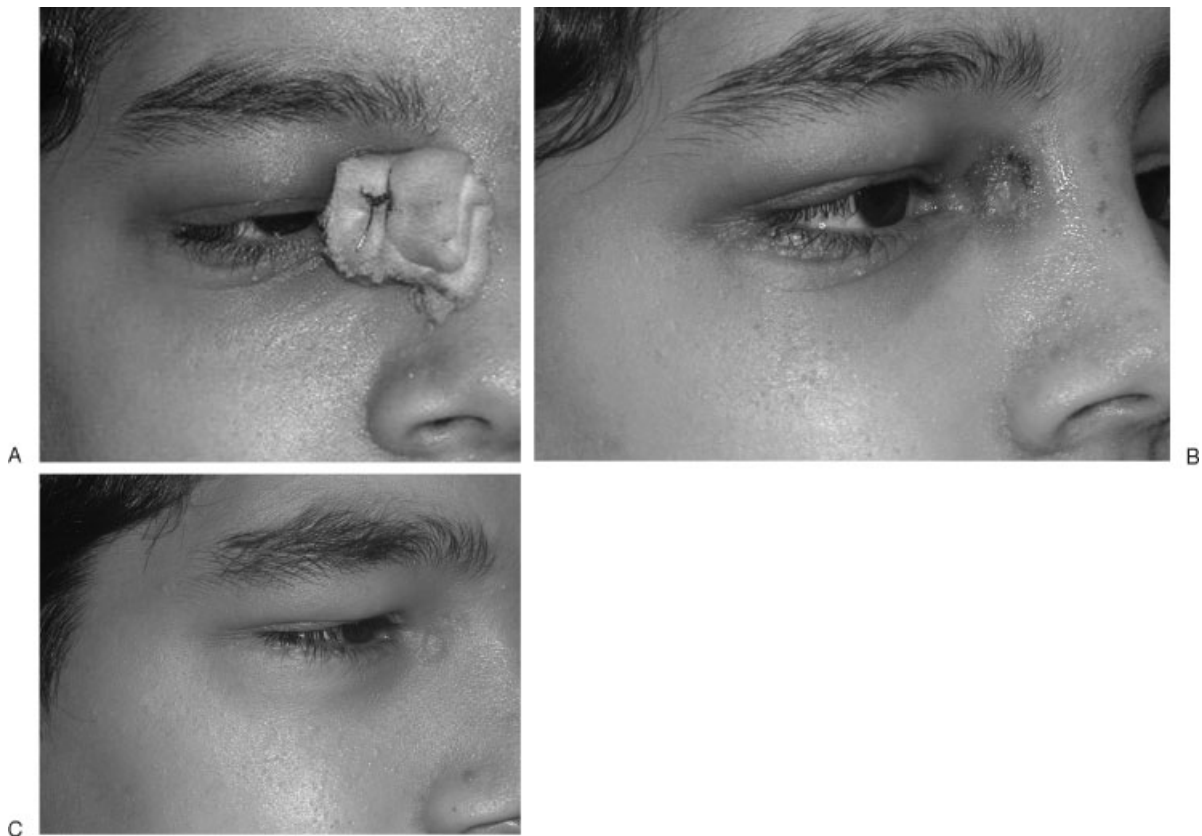


Figure 4 (A) Bolstering postoperatively helps to allow tissue adherence to the underlying NOE “valley.” (B) Erring on the side of leaving the bolster on for longer can actually lead to improved outcomes; in the photograph, the tissue defect after 6 weeks of bolstering is demonstrated. (C) Long-term follow-up outcome at 1 year postoperatively, after allowing for the defect to heal secondarily.

the nose to this point of attachment. The point at which drilling begins is not critical. This is simply a starting point. The point of exit is, however, critical, as this is the point to which the tendon will be secured. The suture is then placed through the hole in the drill bit and pulled through the contralateral nose. Should a bilateral canthopexy be indicated, the identical procedure is accomplished on the contralateral side, and these two sutures are tied to one another. If being performed unilaterally, the suture is typically secured to a screw or small plate placed in the frontal region. It should be stated in unequivocal terms that one cannot overcorrect enough. The surgeon should, however, complete all aspects of reduction and fixation prior to securing the sutures.

If it is believed that the nasal dorsal support is inadequate, typically a cranial bone graft is harvested (as it is readily available through the coronal incision) and either plated or lag screwed into the region of the nasal radix. The distal aspect of this graft should be tucked under the lower lateral cartilages to prevent palpability. Costochondral graft has also been preferred by some for its ability to provide cartilage to the nasal tip.⁸

Once all of the above has been accomplished and one is ready to secure the transnasal sutures, preparation should be made to place a soft tissue bolster. It is critical

in the healing phase that pressure be applied externally on the soft tissue in the medial canthal region. Without this external pressure, this area of degloved soft tissue fills with blood and serum and precludes the tight adherence between the skin and underlying bone necessary to give normal contours in this medial canthal “valley.” To do this, it is typically easiest to take a very large suture on a cutting needle and pass it from one medial canthal region through or below the nasal bones under direct vision and out the skin of the other medial canthal region. This is done with two sutures, and these are left long on either side. The MCT is then secured and the wound irrigated and closed. At this point, any type of material such as felt or Xeroform (Tyco Healthcare, Mansfield, MA) is placed in the region of the medial canthal valley and the suture tied over this quite firmly to provide the external pressure that is so critical in obtaining an excellent result. Postoperatively, this soft tissue bolster is left in position for at least a week, and often longer. Some of the best results seen have been when these patients have been lost to follow-up and present 6 weeks or longer postoperatively. In these cases, the soft tissue is frequently ulcerated. As we know from Mohs’ reconstruction, perhaps the best area to heal from secondary intention is the concavity of the medial

canthal region. Secondary intention healing here allows the soft tissue to adhere very tightly to the underlying recontoured bone and skeletal structure and mimic the normal state (Fig. 4).

COMPLICATIONS

The complications seen after NOE fracture management relate to the status of the MCT and the nasolacrimal duct. The most vexing complication is persistent telecanthus. This is almost impossible to adequately treat secondarily. If one does approach it, typically the area needs to be refractured and the medial canthal bone fragment reduced more medially. In these situations, the soft tissue overlying this area needs to be thinned directly using scissors to rid it of the fibrosis that typically adds to the poor appearance. It is all the more important in these secondary situations to aggressively place soft tissue bolsters as described above.

Another issue seen postoperatively is epiphora due to nasolacrimal duct obstruction. Studies have demonstrated that close to 50% of patients can present with epiphora immediately postoperatively.⁴ A significant portion of these cases will resolve spontaneously with resolution of soft tissue swelling. Persistent nasolacrimal tract obstruction after open reduction and internal fixation is rare, occurring only 5 to 10% of the time.^{5,8} Given this, it is best to treat persistent epiphora after reduction and fixation of these injuries secondarily, 6 months or more after fracture treatment. Studies have found a correlation between the amount of bone loss in the nasolacrimal region and the risk of persistent postoperative epiphora. In one study, 86% of individuals with bone loss in the lacrimal fossa had permanent epiphora.⁴ The incidence climbed to 100% when therapy was delayed for more than 2 weeks.

CONCLUSION

NOE injuries can be difficult to manage. Proper assessment and early surgical management of the NOE and

concomitant injuries are key to optimal outcomes. Over-correction of the bony position and compression of the soft tissue overlying the MCT are critical. Residual telecanthus tends to be recalcitrant despite the best efforts.

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