The Importance of Accurate, Early Bony Reconstruction in Orbital Injuries with Globe Loss

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ABSTRACT

Patients who sustain facial fractures frequently suffer from visual disturbance. Additionally, orbital fractures often involve ocular injury, which, not infrequently, may require enucleation. Yet an anophthalmic orbit does not obviate the need for aggressive orbital fracture treatment. In fact, treatment of the sequelae of the anophthalmic orbit can be difficult and require multiple surgeries. Intraoperative use of a conformer after accurate bony reduction and orbital reconstruction with bone grafts or orbital implants are essential steps to allow for prosthetic rehabilitation of the anophthalmic orbit.

KEYWORDS: Orbital trauma, globe loss, enucleation, enophthalmos, ptosis, anophthalmic orbit syndrome

Craniomaxillofacial trauma frequently involves injury to the periorbital region. Orbital fractures can occur in isolation, as with orbital floor or medial wall fractures, or in conjunction with other midface or cranial fractures as with LeFort III, LeFort II, naso-orbital-ethmoid, cranial base/orbital roof, zygomaticomaxillary, or panfacial fractures. Data from busy trauma centers suggest a rate of ocular injuries in patients with facial fractures of between 10% and 30%¹⁻³ depending on location of bony fracture. Ocular trauma necessitating enucleation is less common, but not a rare injury. Jabaley et al reported a 6% incidence of acute enucleation in 119 patients with orbital fractures.⁴ In this circumstance, proper correction of orbital fractures often is neglected or inadequately performed, perhaps due to the belief that accurate orbital reconstruction is not necessary in the absence of a seeing eye. We have found the exact opposite to be the case. Accurate, anatomic reconstruction of the bony orbit at the time of the acute trauma is

absolutely essential to prevent or minimize the multitude of problems common to the posttraumatic anophthalmic orbit and to facilitate prosthetic rehabilitation.

METHODS

Given the senior author's experience with craniomaxillofacial trauma, we have developed the following protocol for treatment of periorbital facial fractures with concomitant globe injury at Harborview Medical Center. Patients with suspected facial fractures undergo a trauma workup including a fine-cut maxillofacial computed tomography (CT) scan with coronal and sagittal reconstructions as well as cervical spine films and computed tomographic angiography of the carotids to rule out concurrent injuries. An ophthalmologic examination is performed on all patients found to have either facial fractures or visual disturbances to rule out injury to the globe. If the ophthalmologists determine the globe is not

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salvageable and requires enucleation, the procedure is planned in coordination with repair of the orbital fractures. If medically possible, all fractures are fixed within the first 2 weeks after injury.

At time of surgery, the enucleation is performed and orbital conformers are placed. Use of a conformer is essential to prevent soft tissue contractures within the orbit. Once the conformer is placed, orbital fractures are anatomically reduced and fixated. Bone grafting of all orbital wall defects is then performed using either split calvarial, cortical iliac crest, or split rib grafts. Additional bone grafts are then placed as needed to bring the conformer to the appropriate anteroposterior and vertical level when compared with the opposite side. Titanium mesh or MedPor[®] Titan (Porex Surgical Products Newnan, GA) implants are used when necessary in severely comminuted cases to support the bone grafts. The goal of reconstruction is the creation of an orbit of proper anatomic shape and dimensions and of a volume such that the orbital conformer lies in the same position as the globe on the unaffected side. Although this approach relies on considerable subjective assessment, it certainly results in a more favorable rehabilitation of the anophthalmic orbit than will delayed fracture treatment.

Frequently, even after proper anatomic reduction of orbital fractures and prosthetic rehabilitation, a supratarsal hollow persists within the soft tissue of the upper orbit. This can be treated secondarily, after swelling has subsided and scars have matured, with soft tissue augmentation. Depending on the severity of the deficiency, either dermal fat grafts or microfat injections can be used to fill in this hollowing. Dermal fat grafts are placed through an upper eyelid incision, and microfat injections can be placed through small stab incisions around the orbit using a blunt-tip cannula to avoid retinal artery embolism. In either case, the surgeon should plan to overcorrect the volume deficiency to anticipate some atrophy of the grafted fat.

DISCUSSION

It goes without saying that vision is an important component of peoples' daily lives. Additionally, vision is commonly affected in patients who have suffered facial trauma. When vision was measured prospectively in patients with facial fractures by Al-Qurainy et al, they found 90% of patients with midface injuries to have sustained ocular injuries of various severities.⁵ Moreover, durable visual complaints were described in 47% of patients with comminuted LeFort fractures, and these disturbances of vision were commonly cited as the impediment to return to work and to normal activities of daily living.⁶ Although the majority of these visual complaints are minor or transient, the incidence of blindness secondary to blunt facial trauma has been

reported at 3 to 12%.⁷⁻⁹ Relatively few of these blinding injuries require enucleation, although Jabaley et al, in one of the few studies to directly address this topic, reported an incidence of enucleation of 6% in 119 patients with orbital fractures treated at a regional trauma center.⁴

Although the treatment of orbital fractures has been well described,¹⁰⁻²⁰ very little attention has been paid in the literature to the management of orbital fractures associated with severe globe injury (Figs. 1, 2 and 3). Miller and Tenzel²¹ described five cases of significant globe damage occurring in 30 patients with midface fractures treated over a 12-month span, but none required enucleation. Markowitz et al²² described six patients with high-energy facial fractures and traumatic hypertelorism, four of whom had globe injuries resulting in blindness and three of whom were left bilaterally blind. No mention of enucleation was made, but of the four with globe rupture, all were found postoperatively to have residual enophthalmos. It is possible that the enophthalmos was due to the limited intraorbital dissection and minimal orbital reconstruction performed at time of injury, explained by the authors as due to concern for iatrogenically worsening the globe rupture. Lauer et al reported four cases of reconstruction of the anophthalmic socket after gunshot wound injury.²³ The cases presented displayed enophthalmos of the prosthetic and anophthalmic orbit syndrome, possibly due to the large orbital volumes seen in the postoperative CT scans they presented. Finally, Rubin et al report on 20 patients with severe orbital

Figure 1 Complex orbitozygomatic and midface fractures with severe soft tissue injury and globe rupture.

Figure 2 Open reduction and internal fixation of fractures with early primary bone graft reconstruction of orbit and zygoma.

fractures requiring internal orbital rigid skeletal fixation.²⁴ Three patients in this group underwent enucleation prior to fracture repair, and one subsequently required further bone grafting of the orbit to correct enophthalmos of the prosthesis.

In contrast to the relative dearth of information regarding acute treatment of the anophthalmic orbit in trauma, secondary management concepts for the anophthalmic orbit have been well reported in the literature.²⁵⁻³² In general, patients who have undergone enucleation and wish to pursue reconstruction first have an implant placed within the orbit followed

Figure 3 Postoperative appearance prior to fitting with ocular prosthesis. Note accurate correction of bimalar width and projection.

Figure 4 Postoperative appearance with ocular prosthesis in place. Note enophthalmos of prosthesis due to inadequate orbital volume reconstruction. Also note hypoglobus and supratarsal hollow.

Figure 5 Coronal and axial computed tomography scans demonstrating unrepaired orbital floor and medial wall fractures with loss of ethmoid "bulge," thereby increasing effective orbital volume and resulting in enophthalmos of ocular prosthesis.

Figure 6 Axial computed tomography scan after logging injury resulting in comminuted orbitozygomatic fractures, Naso-orbital-Ethmoid (N.O.E.) fractures, and globe rupture.

Figure 7 Postoperative X-ray demonstrating accurate bony orbital and midface reconstruction.

by fitting of an ocular prosthesis to match the contralateral side. However, a gradual, progressive deformity known as the anophthalmic orbit syndrome is known to occur after this reconstruction (Fig. 4). This syndrome, described by Sergott and Vistnes,²⁵ is char-

acterized by enophthalmos of the prosthesis, superior orbital sulcus depression, and lower eyelid ptosis. Several etiologies have been postulated: (1) levator disinsertion; (2) atrophy of orbital fat; (3) loss of volume when the globe is removed; (4) depression in

Figure 8 Postoperative appearance after fitting with ocular prosthesis in left orbit. Note proper positioning of prosthesis with accurate orbital bony reconstruction.

the floor of the orbit due to an unrecognized fracture in the rare patient (Fig. 5); and (5) malposition of the superior rectus muscle. It has been well established that the volume deficits must be corrected first and various materials including bone, cartilage,³³ dermis,³⁴ glass,³⁵

and vulcanized silicone³⁶ have been advocated in the *nontraumatic* anophthalmic orbit. Some authors believe that correction of orbital volume will push the prosthesis upward and out, which often results in simultaneous correction of upper lid ptosis and superior sulcus

Figure 9 (A, B) Anteroposterior and lateral view of normal globe position and normal orbital anatomy (left). (C, D) Narrow aperture secondary to enophthalmos of conformer and ocular shell due to uncorrected orbital floor blowout fracture (center). (E, F) Attempts to correct enophthalmos with larger, heavier conformer and thicker ocular shell rather than orbital reconstruction result in stretching of lower eyelid and ectropion.

depression.²⁵ It would seem a more simplistic approach would involve constructing a larger ocular prosthesis to fill the enlarged orbit, but attempts to substitute a larger implant are largely unsuccessful. Large prostheses are, by virtue of their size, quite heavy. This additional weight overcomes the resistance of the lower eyelid, resulting in repeated extrusion from the orbit (Fig. 6). Therefore, reduction of the orbital volume to allow use of a small, light ocular prosthesis is essential to the correction of the anophthalmic orbit syndrome (Figs. 7, 8, and 9).

It is clear from the experience with the non-traumatic anophthalmic orbit that increased orbital volume results in an orbit that cannot be rehabilitated without surgical volume reduction. Consequently, volume reduction is of vital importance in the management of orbital fractures with concomitant globe enucleation. Orbital fractures must be reduced anatomically, even in the absence of a globe, to allow both a superior aesthetic result and placement of a properly sized ocular prosthesis. Although it is clear that an enlarged orbit will lead to prosthetic enophthalmos, the degree to which orbital volume should be reduced is not as evident. The literature on the management of the nontraumatic anophthalmic orbit suggests enophthalmos is common even in a normal bony orbit, thus further volume reduction is often required to attain proper globe position. The experience of Rubin et al would seem to confirm this concept as, despite accurate reduction and fixation of orbital fractures, further bone grafting was required in one enucleated patient to correct prosthetic enophthalmos.²⁴

CONCLUSION

Special surgical attention is necessary for orbital fractures accompanied by severe globe injuries that require enucleation. Accurate fracture reduction, orbital bone grafting, and intraoperative use of a conformer are essential steps to allow for prosthetic rehabilitation of the anophthalmic orbit.

REFERENCES

- MacKinnon CA, David DJ, Cooter RD. Blindness and severe visual impairment in facial fractures: an 11 year review. *Br J Plast Surg* 2002;55:1-7
- Nagase DY, Courtemanche DJ, Peters DA. Facial fractures—association with ocular injuries: a 13-year review of one practice in a tertiary care centre. *Can J Plast Surg* 2006; 14:167-171
- Shere JL, Boole JR, Holtel MR, Amoroso PJ. An analysis of 3599 midfacial and 1141 orbital blowout fractures among 4426 United States Army Soldiers, 1980-2000. *Otolaryngol Head Neck Surg* 2004;130:164-170
- Jabaley ME, Lerman M, Sanders HJ. Ocular injuries in orbital fractures. A review of 119 cases. *Plast Reconstr Surg* 1975;56:410-418
- al-Qurainy IA, Stassen LF, Dutton GN, Moos KF, el-Attar A. The characteristics of midfacial fractures and the association with ocular injury: a prospective study. *Br J Oral Maxillofac Surg* 1991;29:291-301
- Giroto JA, MacKenzie E, Fowler C, Redett R, Robertson B, Manson PN. Long-term physical impairment and functional outcomes after complex facial fractures. *Plast Reconstr Surg* 2001;108:312-327
- Holt GR, Holt JE. Incidence of eye injuries in facial fractures: an analysis of 727 cases. *Otolaryngol Head Neck Surg* 1983; 91:276-279
- Holt JE, Holt GR, Blodgett JM. Ocular injuries sustained during blunt facial trauma. *Ophthalmology* 1983;90:14-18
- Joseph E, Zak R, Smith S, Best WR, Gamelli RL, Dries DJ. Predictors of blinding or serious eye injury in blunt trauma. *J Trauma* 1992;33:19-24
- Cullen GC, Luce CM, Shannon GM. Blindness following blowout orbital fractures. *Ophthalmic Surg* 1977;8:60-62
- Glassman RD, Manson PN, Vanderkolk CA, et al. Rigid fixation of internal orbital fractures. *Plast Reconstr Surg* 1990;86:1103-1109; discussion 1110-1111
- Hammer B. *Orbital Fractures: Diagnosis, Operative Treatment, Secondary Corrections*. Kirkland, WA: Hogrefe and Huber Publications; 1995
- Paskert JP, Manson PN, Iliff NT. Nasoethmoidal and orbital fractures. *Clin Plast Surg* 1988;15:209-223
- Chen CT, Chen YR, Tung TC, Lai JP, Rohrich RJ. Endoscopically assisted reconstruction of orbital medial wall fractures. *Plast Reconstr Surg* 1999;103:714-720; quiz 721
- Messinger A, Radkowski MA, Greenwald MJ, Pensler JM. Orbital roof fractures in the pediatric population. *Plast Reconstr Surg* 1989;84:213-216; discussion 217-218
- Losee JE, Afifi A, Jiang S, et al. Pediatric orbital fractures: classification, management, and early follow-up. *Plast Reconstr Surg* 2008;122:886-897
- Cole P, Boyd V, Banerji S, Hollier LH Jr. Comprehensive management of orbital fractures. *Plast Reconstr Surg* 2007; 120(7, Suppl 2):57S-63S
- Burm JS, Chung CH, Oh SJ. Pure orbital blowout fracture: new concepts and importance of medial orbital blowout fracture. *Plast Reconstr Surg* 1999;103:1839-1849
- Converse JM, Smith B, Obear MF, Wood-Smith D. Orbital blowout fractures: a ten-year survey. *Plast Reconstr Surg* 1967; 39:20-36
- Patel BC, Hoffmann J. Management of complex orbital fractures. *Facial Plast Surg* 1998;14:83-104
- Miller GR, Tenzel RR. Ocular complications of midfacial fractures. *Plast Reconstr Surg* 1967;39:37-42
- Markowitz BL, Manson PN, Yaremchuk M, Glassman D, Kawamoto H. High-energy orbital dislocations: the possibility of traumatic hypertelorism. *Plast Reconstr Surg* 1991;88: 20-28; discussion 29-30
- Lauer SA, Rizzuto PR, Goodrich J, Adamo A. Orbitocraniofacial gunshot wounds: craniofacial reconstruction and preparation of the anophthalmic socket. *J Craniomaxillofac Trauma* 1995;1:21-27
- Rubin PA, Shore JW, Yaremchuk MJ. Complex orbital fracture repair using rigid fixation of the internal orbital skeleton. *Ophthalmology* 1992;99:553-559

25. Sergott TJ, Vistnes LM. Correction of enophthalmos and superior sulcus depression in the anophthalmic orbit: a long-term follow-up. *Plast Reconstr Surg* 1987;79:331–338
26. Vistnes LM. Mechanism of upper lid ptosis in the anophthalmic orbit. *Plast Reconstr Surg* 1976;58:539–545
27. Fry HJ. The enucleated eye socket. *Br J Plast Surg* 1968;21:290–293
28. Nolan WB III, Vistnes LM. Correction of lower eyelid ptosis in the anophthalmic orbit: a long-term follow-up. *Plast Reconstr Surg* 1983;72:289–293
29. Clauser L, Sarti E, Dallera V, Galìè M. Integrated reconstructive strategies for treating the anophthalmic orbit. *J Craniomaxillofac Surg* 2004;32:279–290
30. Vistnes LM, Iverson RE, Laub DR. The anophthalmic orbit. Surgical correction of lower eyelid ptosis. *Plast Reconstr Surg* 1973;52:346–351
31. Li D, Jie Y, Liu H, Liu J, Zhu Z, Mao C. Reconstruction of anophthalmic orbits and contracted eye sockets with micro-vascular radial forearm free flaps. *Ophthal Plast Reconstr Surg* 2008;24:94–97
32. Habal MB. Aesthetic considerations in the reconstruction of the anophthalmic orbit. *Aesthetic Plast Surg* 1987;11:229–239
33. Linberg JV, Anderson RL, Edwards JJ, Panje WR, Bardach J. Preserved irradiated homologous cartilage for orbital reconstruction. *Ophthalmic Surg* 1980;11:457–462
34. Smith B, Petrelli R. Dermis-fat graft as a movable implant within the muscle cone. *Am J Ophthalmol* 1978;85:62–66
35. Smith B, Obear M, Leone CR Jr. The correction of enophthalmos associated with anophthalmos by glass bead implantation. *Am J Ophthalmol* 1967;64:1088–1093
36. Nasr AM, Jabak MH, Batainah Y. Orbital volume augmentation with subperiosteal room-temperature-vulcanized silicone implants: a clinical and histopathologic study. *Ophthal Plast Reconstr Surg* 1994;10:11–21; discussion 22–23