Recurrent Orbital Trauma Following Repaired Orbital Floor Fracture

Benjamin Homer, Alexander Homer,* Stephen R. Sullivan, MD, MPH,† and Helena O. Taylor, MD, PhD†*

Abstract: A study of a 22-year-old male who was assaulted and sustained a left orbital floor blowout fracture was presented in this study. The orbital floor was repaired with a titanium-reinforced porous polyethylene implant. Two years postoperatively, the patient sustained repeated left orbital trauma. The orbital floor implant remained stable while the medial wall blew out.

Key Words: Assault, medial orbital wall fracture, orbital floor fracture

The facial skeleton has evolved to protect the globe with adjacent maxillary, ethmoid, and frontal sinuses. The preferential fracture of the orbital floor and medial orbital wall allows the sinuses to effectively act as "crumple zones," protecting against globe injury or rupture. Typically, significant fractures of the orbital floor are repaired with implants or bone grafts to restore orbital volume and prevent enophthalmos, hypoglobus, or diplopia. Implants and bone grafts are inherently more rigid than the native orbital bone, which could jeopardize the well-designed protective blow-out mechanism of the orbital walls. An orbital blow-out fracture is an increase in orbital volume with orbital contents and bony orbital wall fragments expanding into the surrounding sinuses, including the maxillary and ethmoid sinuses.

We present a patient with recurrent trauma to the orbit after orbital floor reconstruction with an implant. In this study, the orbital floor implant remained intact while the medial orbital wall sustained a blow-out fracture into the ethmoid sinuses. This suggests that the medial orbital wall may be at higher risk of fracture after orbital floor repair, while remaining an effective protective mechanism against globe injury or rupture.

CLINICAL REPORT

A 22-year-year old male was assaulted and sustained facial trauma around the orbit. Computed tomography (CT) scan demonstrated an isolated left orbital floor blowout fracture (Fig. 1A). The patient underwent repair two and a half weeks postinjury and the orbital floor was reconstructed using a SynPOR (DePuy Synthes, Zuchwil, Switzerland) porous polyethylene titanium-reinforced implant. The implant was secured with a single 4-mm screw along the orbital rim. Twenty-seven months after this repair, he sustained another assault to the left orbit. He presented with periorbital swelling, photosensitivity, and pain. Ophthalmologic examination demonstrated left traumatic iritis with subconjunctival hemorrhage and chemosis, 3 cm laceration superficial to the upper lateral orbital rim, and periorbital edema. Visual acuity, pupils, vitreous, retina, and intraocular pressures were all normal. The CT imaging revealed an intact orbital floor reconstruction and a new medial orbital wall blow-out fracture (Fig. 1C). He did not return for follow-up. One month later, he again presented to the emergency department with nasal bone fractures following another assault.

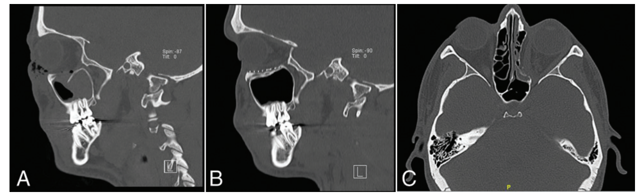

FIGURE 1. (A) Initial sagittal computed tomography (CT) showing isolated left orbital floor fracture with fluid in maxillary sinus. (B) Subsequent sagittal CT scan demonstrating the left orbital floor reconstruction with titanium-reinforced porous polyethylene implant after secondary trauma. (C) Axial CT demonstrating left medial orbital wall blowout fracture after secondary trauma.

DISCUSSION

Orbital floor fractures account for nearly 3% of all emergency department visits in the United States.[1] Through the hydraulic mechanism, as little as 2.08 J of force to the globe can be transferred to the orbital floor, which acts as a crumple zone and blow-out to prevent globe rupture.[2,3] A CT scan accurately demonstrates the size and location of orbital fractures. Treatment is largely dependent on the severity of the blowout and the attendant risk of developing enophthalmos, hypoglobus, or diplopia. Restriction in upward gaze, which might be accompanied by pain, or bradycardia, may indicate entrapment of the inferior rectus muscle or the adjacent septa, mandating more urgent intervention to prevent fibrosis of the inferior rectus and permanent diplopia. Given the frequency of concurrent globe and optic nerve injury, a comprehensive ophthalmologic evaluation is recommended.[4]

If surgery is indicated, various materials can be used to reconstruct the floor, including bone grafts, titanium, porous polyethylene, or titanium-reinforced porous polyethylene. All these materials are more rigid than the native orbital floor bone.[5–9] For example, polydioxanone foil and collagen membranes both have a puncture force of 5 and 1.6 N, respectively. The same study found that the orbital floor could only withstand 0.12 N.

As seen in Figure 1C, these materials can resist fracture or displacement in the event of repeat orbital trauma. While the reconstructed orbital floor remains intact, it no longer effectively acts as a crumple zone to protect the globe from rupture.[10,11] Nevertheless, from this report we can see that the force of repeat orbital trauma in the setting of a repaired orbital floor is transmitted to the medial orbital wall, resulting in a medial wall blow-out fracture. This suggests that the medial orbital wall serves as an effective reserve crumple zone and protective mechanism for orbital trauma following orbital floor repair with implant. In patients with repeat orbital trauma, the medial wall should be carefully evaluated.[12] Indications for surgery concerning an isolated medial wall fracture include clinically significant enophthalmos, entrapment of the medial recuts muscle and bradycardia with attempted eye movement. The transcaruncular medial orbitotomy approach of the medial wall is favored and has replaced the more traditional percutaneous frontoethmoidal approach. If surgery is not indicated, patients should be followed to see if clinically significant enophthalmos develops. No other intervention is required otherwise.[13]

From *Brown University, Providence, RI; and †Division of Plastic and Reconstructive Surgery, Harvard Medical School, Mount Auburn Hospital, Cambridge, MA.
Received June 14, 2019.
Accepted for publication October 15, 2019.
Address correspondence and reprint requests to Benjamin Homer, Brown University, 69 Brown Street, Mail #2868, Providence, RI 02912;
E-mail: benjamin_homer@brown.edu
The authors report no conflicts of interest.

ISSN: 1049-2275
DOI: 10.1097/SCS.0000000000006176

CONCLUSION

Orbital floor reconstruction is the standard of care for large orbital floor fractures.[5] An orbital floor fracture properly repaired with an implant remains intact despite the forces of repeated trauma and appears to change the dynamics of the orbit as it no longer serves as a crumple zone into the adjacent maxillary sinus. The medial orbital wall and ethmoid sinuses then act as an effective reserve crumple zone and pressure outlet in the setting of repeat trauma. In patients with repeat facial trauma after orbital floor repair, the medial orbital wall should be scrutinized for fracture.

REFERENCES

1. Bord SP, Linden J. Trauma to the globe and orbit. *Emerg Med Clin North Am* 2008;26:97–123
2. Green RP, Peters DR, Shore JW, et al. Force necessary to fracture the orbital floor. *Ophthal Plast Reconstr Surg* 1990;6:211–217
3. Patel S, Andrecovich C, Silverman M, et al. Biomechanic factors associated with orbital floor fractures. *JAMA Facial Plast Surg* 2017;19:298–302
4. Ceallaigh PO, Ekanaykaee K, Beirne CJ, et al. Diagnosis and management of common maxillofacial injuries in the emergency department. Part 4: orbital floor and midface fractures. *Emerg Med J* 2007;24:292–293
5. Mok D, Lessard L, Cordoba C, et al. A review of materials currently used in orbital floor reconstruction. *Can J Plast Surg* 2004;12: 134–140
6. Birkenfeld F, Steiner M, Kern M, et al. Forces affecting orbital floor reconstruction materials–a cadaver study. *J Craniomaxillofac Surg* 2013;41:e24–e28
7. Birkenfeld F, Steiner M, Kern M, et al. Maximum forces applied to the orbital floor after fractures. *J Craniofac Surg* 2012;23:1491–1494
8. Birkenfeld F, Steiner M, Becker ME, et al. Forces charging the orbital floor after fractures. *J Craniofac Surg* 2011;22:1641–1646
9. Hwang K, Kim DH. Comparison of the supporting strength of a poly-L-lactic acid sheet and porous polyethylene (Medpor) for the reconstruction of orbital floor fractures. *J Craniofac Surg* 2010;21:847–853
10. Kellman RM, Schmidt C. The paranasal sinuses as a protective crumple zone for the orbit. *Laryngoscope* 2009;119:1682–1690
11. Ahmad F, Kirkpatrick WN, Lyne J, et al. Strain gauge biomechanical evaluation of forces in orbital floor fractures. *Br J Plast Surg* 2003;56: 3–9
12. 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
13. Thiagarajah C, Kersten RC. Medial wall fracture: an update. *Craniomaxillofac Trauma Reconstr* 2009;2:135–139