Orbital Floor Fractures: a review of different management options

Mohamed E. Khalil Esmail MD[*], Mohamed F. Khalil Ibrahiem MD[*], Raafat M. Abdelrahman MD[*], Ahmed M. Kamal Elshafei MD, FRCS (Glasg.)[1], and Tamer I. Gawdat MD, FRCS (Ed.)[2]

* Department of Ophthalmology, Minia University, Minia, Egypt

** Department of Ophthalmology, Faculty of Medicine, Cairo University, Cairo, Egypt

Introduction

Orbital floor fractures have been recognised as an entity since the first case reported by Lang in 1989. [1] The term *blowout fracture* was coined in 1957 by Drs. Byron Smith and William Regan to describe a hydraulic fracture of the orbit resulting from an object slightly larger than the circumference of the orbit.[2] The mechanism involved in these injuries has not yet been completely defined. Two theories have been described, which seem to be mutually exclusive. They are named as the buckling and hydraulic theories [3]

Keywords: Blow-out fractures, enophthalmos, orbital trauma

Epidemiology of orbital floor blow-out fractures:

Pure orbital floor fractures can be seen in 22 to 47 percent of orbital injuries. The patients are usually in the second to the fourth decade of age and are commonly males.[3]

Common signs and symptoms of orbital floor fractures include localized pain, diplopia and peribulbar ecchymosis, eyelid edema, subcon-junctival hemorrhage, and sensory deficits in the inferior orbital nerve distribution. The physical examination should begin with inspection of the orbit and periorbital tissues. Any lacerations or bony step offs are noted, and the patient should be assessed for enophthalmos and/or hypoglobus. [4]

Radiographic evaluation

Historically, plain X-ray films were used to delineate bony details of the orbit and face. ***Water and Waldron*** described in 1915 a radio-graphic projection that eliminated the over-lapping shadows of the dense ridge of temporal bone. ***Water's view*** provides a good image of the orbital rim, maxillary sinus and zygomatic bone.[5] Nowadays, advances in computed tomo-graphy (CT) technology have made coronal and sagittal reconstructions from axial scans readily available. Coronal images with 1-2 mm sections remain the most useful method for assessing orbital floor fractures; however, sagittal reconstructions can be particularly helpful in determining the premorbid shape of the orbit before attempted reconstruction. CT scanning provides reliable information on the size of the defect and status of the globe and extraocular muscles, and evidence of entrapment. Magnetic resonance imaging (MRI) is helpful in identifying orbital soft tissue injury or prolapse. [6]

Indications and timing of surgical management

Clinical decision-making in the management of patients with orbital fractures is challenging. Controversies exist regarding the indications for surgery, the timing of surgery, and the best reconstruction material. In orbital trauma surgery, a general distinction is made between immediate (within hours), early (within 2 weeks), and late surgical intervention. [7]

The indication for repair of orbital wall fractures is based on a combination of clinical findings and radiological information. However, among 55 studies per-formed on orbital reconstruction, it was found that the indication for surgery was based on diplopia in only 18.3% of cases and on preoperative enophthalmos in only 29.8% of cases. The other two most frequently reported indications for orbital reconstruction are defect size and incarcerated tissue, with both identified on CT scans. [8]

There is a strong consensus on the indications for immediate repair, but clinicians face challenges in identifying patients with minimal defects who may actually benefit from delayed surgical treatment. Moreover, controversies exist regarding the risk of late surgery-related orbital fibrosis, since traumatic ocular motility disorders sometimes recover spontaneously and therefore do not necessarily require surgery. [7]

Burnstine criteria for orbital fracture surgery timing [9]

1) **Immediate repair: (within 24 hours) :**
   - Diplopia with CT evidence of an entrapped muscle or peri-orbital tissue associated with a non-resolving oculo-cardiac reflex
   - 'White-eyed blowout fracture', young patient (<18 years), history of peri-ocular trauma, little ecchymosis or oedema (white eye), marked extrao-cular motility vertical restriction, and CT examination revealing an orbital floor fracture with entrapped muscle or peri-muscular soft tissue
   - Early enophthalmos/ hypoglobus causing facial asymmetry
2) **Early repair: (within 1-14 days):**
   - Symptomatic diplopia with positive forced duction, evidence of an entrapped muscle or peri-muscular soft tissue on CT examination, and minimal clinical improvement over time
   - Large floor fracture causing latent enophthalmos
   - Significant hypoglobus
   - Progressive infraorbital hyposthesia
3) **Observation or delayed repair:**
   - Minimal diplopia (not in primary or downgaze), good ocular motility, and no significant enophthalmos

Techniques of surgical repair

Incision Patterns

There are several approaches described to access the orbital floor. Many have abandoned the ***subciliary incision***, which has demonstrated an unacceptably high risk of cicatricial ectropion. [10]

The ***subtarsal incision*** offers direct orbital floor access and is less technically demanding, but may leave visible scarring. A recent compre-hensive review of incision techniques found insufficient high-level evidence to suggest one pattern over another, but did show a low incidence of complications with transcon-junctival approaches, the highest rate of complications and revisions in subciliary approaches, and the lowest revision rate with subtarsal incisions. [11]

The ***transconjunctival approach*** has been most extensively studied and shows low rates of complications and leaves no visible scar; however, this approach often requires lateral canthotomy for complete exposure and there is a small risk of cicatricial entropion with this incision pattern. Furthermore, a higher incidence of ectropion was found in patients with previous external eyelid incisions. [10]

The main drawback of the transconjunctival and subciliary approaches to the orbital floor is difficulty visualizing the posterior edge of a fracture due to its distance (remoteness) and prolapse of adipose tissue. ***A Transantral or transnasal endoscopic approach*** provides good illumination and visualization of the fracture for all surgery participants. It allows one to evaluate the completeness of release of the entrapped orbital tissues and the position of the posterior edge of the implant. The procedure is indispensable in cases when a fracture extends to the posterior wall of the maxillary sinus because it allows for better securing of the implant and its distal edge on the orbital process of the palatine bone. [12]

It should be noted that the ***transcaruncular incision*** pattern may be associated with incr-eased ophthalmic complications, including nasolacrimal obstruction caused by scar tissue formation. [13]

Floor Reconstruction

Periosteum of the orbital floor is separated along the entire depth of the fracture. The prolapsed soft tissues are returned to the orbit with a spatula placed in the bone defect zone. When performing this step, it is extremely important to identify the infraorbital nerve as promptly as possible to avoid damaging it. Furthermore, it is important to avoid bringing the maxillary sinus mucous membrane into the orbit as it may cause cyst development around the implant. Finally, one needs to avoid excessive pressure exerted on the eye and the optic nerve. Once the orbital contents have been reduced, the orbital floor can be reconstructed using a variety of implant materials. [4]

In the reconstruction of orbital fractures, the purpose of an implant is to restore function and aesthetic appearance by repairing the traumatic defect and bringing the globe into its correct position, thereby avoiding enophthalmos. In addition to the timing and methods of reconstruction, a third essential factor in orbital fracture surgery is the choice of reconstruction material. [14]

Controversy exists regarding the best material features, which can be defined broadly by the following parameters: (1) autogenous versus allogeneic, (2) non-resorbable versus resorbable material, (3) malleable versus preformed anatomical plates, and (4) pre-fabricated versus custom made implants. [15]

References

1. Lang. Injuries and diseases of the orbit. Traumatic enophthalmos with retention of perfect acuity of vision. By William Lang, 1889. *Adv Ophthalmic Plast Reconstr Surg*. 1989; 6: 3-6.
2. Smith B and Regan WF, Jr. Blow-out fracture of the orbit; mechanism and correction of internal orbital fracture. *Am J Ophthalmol*. 1957; 44: 733-9.
3. Punke C, Fritsche A, Martin H, Schmitz KP, Pau HW and Kramp B. [Investigation of the mechanisms involved in isolated orbital floor fracture. Simulation using a finite element model of the human skull]. *HNO*. 2007; 55: 938-44.
4. Gart MS and Gosain AK. Evidence-based medicine: Orbital floor fractures. *Plast Reconstr Surg*. 2014; 134: 1345-55.
5. Konen E, Faibel M, Kleinbaum Y, et al. The value of the occipitomental (Waters') view in diagnosis of sinusitis: a comparative study with computed tomography. *Clin Radiol*. 2000; 55: 856-60.
6. Cole P, Boyd V, Banerji S and Hollier LH, Jr. Comprehensive management of orbital fractures. *Plast Reconstr Surg*. 2007; 120.
7. Dubois L, Steenen SA, Gooris PJ, Mourits MP and Becking AG. Controversies in orbital reconstruction--II. Timing of post-traumatic orbital reconstruction: a systematic review. *Int J Oral Maxillofac Surg*. 2015; 44: 433-40.
8. Gunarajah DR and Samman N. Biomaterials for repair of orbital floor blowout fractures: a systematic review. *J Oral Maxillofac Surg*. 2013; 71: 550-70.
9. Burnstine MA. Clinical recommendations for repair of isolated orbital floor fractures: an evidence-based analysis. *Ophthalmology*. 2002; 109: 1207-10.
10. Kothari NA, Avashia YJ, Lemelman BT, Mir HS and Thaller SR. Incisions for orbital floor exploration. *J Craniofac Surg*. 2012; 23: 1985-9.
11. Lorenz HP, Longaker MT and Kawamoto HK, Jr. Primary and secondary orbit surgery: the transconjunctival approach. *Plast Reconstr Surg*. 1999; 103: 1124-8.
12. Park IH, Lee HM and Yanagi K. Endoscopic transantral and transnasal repair of orbital floor fracture with the ballooning technique, and classification and characterization of orbital floor fractures. *Am J Rhinol Allergy*. 2015; 29: 445-8.
13. Malhotra R, Saleh GM, de Sousa JL, Sneddon K and Selva D. The transcaruncular approach to orbital fracture repair: ophthalmic sequelae. *J Craniofac Surg*. 2007; 18: 420-6.
14. Baino F. Biomaterials and implants for orbital floor repair. *Acta Biomater*. 2011; 7: 3248-66.
15. Dubois L, Steenen SA, Gooris PJ, Bos RR and Becking AG. Controversies in orbital reconstruction-III. Biomaterials for orbital reconstruction: a review with clinical recommendations. *Int J Oral Maxillofac Surg*. 2016; 45: 41-50.