

Prevalence of Intraocular Injuries in Patients with Orbital Blow-Out Fractures

Bahram Eshraghi, MD¹ • Hamidreza Torabi, MD²
Babak Masoomian, MD³ • Mohammad Reza Akbari, MD⁴

Abstract

Purpose: To determine the prevalence of intraocular injuries in patients with blow-out fracture and also to evaluate the etiologic mechanism of orbital blow-out fractures

Methods: This study is a consecutive case series analysis of 116 patients with orbital blow-out fractures. The patients were visited by an ophthalmologist within 24 hours of trauma.

Results: Ninety-one men and twenty-five women with mean age of 29.1±13.9 years were included for this study. Fist trauma and assault (54%) was the most common cause of orbital blow-out fractures. Inferior wall was involved more commonly (49%) than medial wall and combined form. Significant enophthalmos (>2 mm) was present in 26 cases. Orbital reconstruction surgery was performed in 34% of cases. Intraocular injuries were detected in 25% of patients. Hyphema (65%) and commotio retina (39%) were the most frequent detectable intraocular injuries. Intraocular damages were significantly less common in patients with large fractures (synchronous medial and inferior wall fractures or fracture size equal or more than 1/2 of orbital wall) in contrast to small size fractures (p=0.02).

Conclusion: Ocular injuries are relatively common in blow out fractures and ophthalmic examination is mandatory. In our study ocular injuries were less frequent in large fractures than small size fractures that may indicate protective role of orbital integrity or other factors caused by fractures.

Keywords: Ocular Trauma, Blow-out Fracture, Buckling Theory, Enophthalmos, Hydraulic Theory

Iranian Journal of Ophthalmology 2014;26(3):160-5 © 2014 by the Iranian Society of Ophthalmology

-
1. Assistant Professor of Ophthalmology, Division of Orbit and Oculoplastic Service, Eye Research Center, Farabi Eye Hospital, Tehran University of Medical Sciences, Tehran, Iran
 2. Fellowship in Posterior Segment, Eye Research Center, Farabi Eye Hospital, Tehran University of Medical Sciences, Tehran, Iran
 3. Fellowship in Pediatric Ophthalmology and Strabismus, Eye Research Center, Farabi Eye Hospital, Tehran University of Medical Sciences, Tehran, Iran
 4. Assistant Professor of Ophthalmology, Division of Pediatric and Strabismus Service, Eye Research Center, Farabi Eye Hospital, Tehran University of Medical Sciences, Tehran, Iran

Received: July 24, 2014

Accepted: December 11, 2014

Correspondence to: Babak Masoomian, MD

Fellowship in Pediatric Ophthalmology and Strabismus, Eye Research Center, Farabi Eye Hospital, Tehran University of Medical Sciences, Tehran, Iran, Email: dr.masoomian@yahoo.com

Financial disclosure: No financial support was received for this submission.

Conflict of interest: None of the authors has conflict of interest with the submission.

Introduction

Orbital blow-out fractures are fractures that occur within the bony orbit, usually along the floor and/or medial walls, where the orbital rims are intact.¹ According to the literature, blow-out fractures account for approximately 11% of fractures involving the orbit.² Blunt orbital trauma can damage both the orbital bony walls and the globe. The bony walls of the orbit, unlike the rim, are thin and the fractures typically occur in the inferior and medial walls which are both the thinnest areas of bone.^{1,2}

Orbital blow-out fracture is presumed by the patient's history. Physical examination, and imaging confirmed the existence of the lesions. Complications such as diplopia, hypoesthesia in the distribution of the infraorbital nerve and enophthalmos, are well-recognized sequels of orbital fractures.^{3,4} Also, concomitant intraocular damage such as hyphema, corneal trauma, traumatic cataract, commotio retinae and retinal detachment may occur.⁵ Therefore an ocular examination must be performed for patients with orbital blow-out fractures. Several investigators have investigated the association between ocular findings and orbital fractures. Lim and colleagues reported ocular injury rate of 4% in such circumstances,⁶ but Jayamanne and colleague reported that the rate was 93%.⁷ The 4% to 93% ocular injury rate reported by ophthalmologists led to further confusion and we were encouraged to do a new investigation on this matter.

Most opinions about the mechanism of blow-out fractures fall under two main theories: the "hydraulic" theory, and the bone conduction (buckling) theory.^{5,8-10}

The purpose of this study is to evaluate the prevalence of intraocular damages in patients with orbital blow-out fractures. Because these patients may be handled by other non-ophthalmologist specialized groups, this study may be able to show the importance of ophthalmologist roles in this event. Furthermore we aimed to assess the consequences and mechanisms of orbital wall fractures.

Methods

This is a consecutive case series study including all patients with orbital blunt trauma that were referred to Farabi Eye Hospital

(within 24 hours after trauma) between May 2009 and February 2011. In the first visit, Socio-demographic data and history regarding the cause of the injuries were obtained. Complete ocular examination including extraocular eye muscles function, orbital margin palpation, slit-lamp examination and fundus examination were performed and data were recorded. During slit-lamp examination we carefully looked for microscopic and macroscopic hyphema, iridodialysis and lens opacity. Intraocular pressure (IOP) was measured at each examination. Orbital CT-scan was performed in patients who were suspected of orbital bone fracture following our physical examination. Blow-out fracture was documented only by orbital CT-scan findings. We used orbital CT to measure fracture size. Our CT scan was set at three mm for the interval between one cut and the next. The configuration of fracture was two dimensional. We used coronal plane for assessment of orbital floor fractures and axial plane for evaluation of medial wall fractures. We were able to estimate fracture size by numbering the scan cuts. Hence, the distance between the anterior and posterior end was calculated. Also; we identified the cut in which the fracture width was greatest and then located the lateral and medial ends.

According to CT-scan findings we divided our patients in two groups: small size fractures and large size fractures. Small size fracture was defined as small fracture (less than $\frac{1}{2}$ wall area) that involved only one orbital wall with or without a linear fracture that may simultaneously extend to another orbital wall. Large size fracture was defined as a fracture that involved more than $\frac{1}{2}$ of one orbital wall or two non-linear fractures of two walls.

Inclusion criteria included clinical and radiological evidence of blow-out fracture (inferior and/or medial orbital wall fracture with intact orbital rim), no signs of sharp trauma and no history of previous ocular injuries. Examination was done by one ophthalmologist within the first 24 hours after trauma. Complete ocular examination was repeated three days, seven days and one month after injury and management methods were recorded (conservative approach or surgical treatment). The results of the assessment were tabulated for analysis with χ^2

and ANOVA (Analysis of Variance) tests. Values of $p < 0.05$ were considered to be statistically significant.

Results

A total of 116 patients with orbital fractures were included for this study. Out of 116 patients 91 (78.5%) were male and 25 (21.5%) were female. The mean age of patients was 29.1 ± 13.9 years (ranged 7 to 65 years) and most frequent decade of age was between the 3rd and 4th decades. The right eye was involved in 56% (N=65) and the left eye was involved in 44% (N=51) of cases. The most common etiologies were assaults and interpersonal violence (54%), motor vehicle related accidents (21%), falls (11%), work accidents (6%) and remainder 8% were due to other mechanisms (Figure 1).

Orbital CT-scan demonstrated that inferior wall fractures occurred in 57 cases (49%). Medial wall was involved in 40 cases (35%) respectively and both walls were involved in 19 cases (16%). According to CT-scan findings 91 cases were categorized in small size fractures and 25 cases were categorized in large size fractures.

Twenty-six patients (22.4%) complained of diplopia in first visit (Table 1). Vertical diplopia was the major type (76%). Most of the patients with diplopia had inferior wall fracture (77%). In patients with small size fractures (91 cases), diplopia was present in 20 patients (22%). In contrast in patients with large size fracture (25 cases), only six patients complained of diplopia (24%).

Hypoesthesia in lower lid and region of the infraorbital nerve distribution was detected in 29 patients (25%). In 14 patients of this group (48%), there was dental anesthesia. Hypoesthesia occurred in 15 patients (16.5%) with small size fractures, in contrast it occurred in 14 patients (56%) with large size fractures (Table 2).

During follow-up, although we found enophthalmos in 37% (N=43) of patients, but only in 26 patients it was more than 2 mm,

which needed reconstruction surgery. Nineteen of 26 (73%) cases with significant enophthalmos had large size fractures.

Corneal epithelial defects and aberrations were detectable in four patients (3.5%) and resolved within the first 72 hours after trauma.

Intraocular injuries were detected in 29 cases (25%). Hyphema (microscopic or macroscopic) was the most common type of intraocular damage (17 cases), followed by commotio retinae (10 cases). In 7 patients, both hyphema and commotio retinae were present. In three patients, severe macroscopic hyphema (total hyphema) caused severe reduction in visual acuity of hand motion (H.M). Iridodysis was detectable in two patients alongside significant hyphema. IOP was elevated in two patients with hyphema and was controlled with medication (Table 3).

Traumatic optic neuropathy occurred in one of our patient due to work accident and the patient's visual acuity was equal to H.M. Although this patient had total hyphema and relative afferent pupillary defect (RAPD) test was significantly positive and after suitable medication, despite the resolution of hyphema, visual acuity did not improve.

Seventeen patients (15%) had associated periorbital injuries, including lids laceration or severe aberration. Six of 17 cases with periorbital injuries lacked associated ocular findings. Eyelid emphysema was detectable in 25 patients (21.7%).

Finally, Orbital reconstruction surgery was performed in 39 cases (34%) and 77 patients (66%) were treated conservatively. The most common cause of orbital reconstruction surgery was extensive fractures and enophthalmos (more than two mm), that were detectable in 28 patients (71.7%). Remainder 11 patients (28.3%) underwent surgery secondary to persistent diplopia and soft tissue entrapment.

Intraocular damage was detected in 28% of cases with small size orbital wall fractures, but only in four patients (16%) with large size fractures. This difference was statistically significant ($p=0.02$).

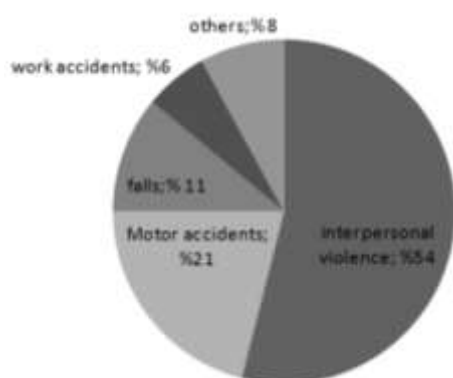


Figure 1. Etiology of orbital blow-out fractures (n=116)

Table 1. Prevalence of lesions after blow-out fractures (n=116)

Lesion	N (%)
Lid Ecchymosis/Hematoma	116 (100)
Lid Emphysema	25 (21.7)
Lid laceration	17 (15)
Subconjunctival hemorrhage	102 (88)
Diplopia	26 (22.4)
Hypoesthesia	29 (25)
Intraocular injuries	29 (25)
Cornea epithelial defect	4 (3.5)
Optic neuropathy	1 (0.86)

Table 2. Comparison between two subgroups of orbital blowout fractures for the prevalence of sign and symptoms

Blow-out fracture Lesion	Small size	Large size
	N=91 N (%)	N=25 N (%)
Diplopia	20 (22%)	6 (24%)
Hypoesthesia	15 (16.5%)	14 (56%)
Intraocular injuries	25 (28%)	4 (16%)
Enophthalmos (>2 mm)	7 (7.7%)	19 (76%)
Need for surgery	18 (20%)	21 (84%)

Table 3. Diversity and prevalence of intraocular injuries in patients with blow-out fractures (N=116)

	Intraocular injuries
	N=29 N (%)
HypHEMA	17 (29)
Iridodialysis	2 (29)
Intraocular pressure rising	2 (29)
Comotio retina	10 (29)
Traumatic optic neuropathy	1 (29)

Discussion

Orbital fractures are managed by many different surgical subspecialties. The role of

the ophthalmologist in the evaluation and management of facial trauma, including orbital fractures, has not been clearly defined. Several investigators have examined the association between ocular findings and orbito-facial fractures.

Many studies have included an ophthalmological assessment of orbito-facial trauma patients, but most of them have failed to clarify when the ophthalmologist evaluated the patients.^{4,11,12} Logically, the ocular injury rate would be higher with an earlier initial ophthalmic evaluation. The 25% overall incidence of ocular injury in our study is similar to that reported by Ashar,¹¹ Gossman¹² and Cook¹³ studies.

Ocular pathologies following periorbital trauma frequently occur and may cause significant visual loss and debility.^{5,8} Blunt ocular trauma causes stretching of limbal tissues, equatorial scleral expansion, posterior displacement of the lens/iris diaphragm, and acute elevation of IOP, with consequent tearing of tissues near the anterior chamber angle. In most patients, blunt trauma to cornea or limbus, causes damage to underlying vascular tissue. This leads to bleeding into the anterior chamber, and a fluid level of blood is often formed.⁸ Corneal abrasion, traumatic iritis, hyphema, lens trauma, vitreous hemorrhage, glaucoma, commotio retinae, retinal detachment and traumatic optic neuropathy may occur in patients with orbital fractures.^{8,13} In our study, hyphema and commotio retinae were the most frequent ocular pathologies. The incidence of traumatic optic neuropathy varies from zero to 14% in different studies,^{4,12-14} and we had one case.

On the CT scan review, we found that the incidence of the inferior orbital wall fractures were more common than medial wall fractures. It is compatible with He et al⁸ report; however some studies reported that medial wall fractures are more frequent than inferior wall involvements.^{15,16} As we mentioned before, we divided our patients in two groups: small size fractures (91 cases) and large size fractures (25 cases). In fact our classification for the size of fracture may indicate the amount of force applied to the orbital cavity.

The causative mechanism in the pathogenesis of orbital blow-out fractures is controversial. The two main proposed

mechanisms include the “buckling” theory and the “hydraulic” theory.^{8,9} The hydraulic theory suggests that increased orbital content pressure compressed the orbital walls, thereby causing fracturing of the thin bones.¹⁰ The most attractive alternate theory is the bone conduction theory, or “buckling” of the infraorbital rim that occurs when a force is applied directly onto it.^{5,8} One major objection for the bone conduction theory is that it cannot easily explain how orbital soft tissues become displaced out of the orbit or get entrapped within the fractured walls of the orbit.¹⁴ In the hydraulic theory, because of increasing in orbital pressure, orbital soft tissues could become displaced and herniated within fractured bone fragments of the orbital walls. Clinical evidence that supports the hydraulic theory for soft tissue entrapment is also offered by the proposed mechanism of “trapdoor” orbital fractures often seen in children.^{8,14} The new theory emphasizes that most blow-out fractures result from a force that is delivered both to the globe and the bony orbital rims. It would therefore be extremely unlikely that a blow from a fist or contact with a dashboard would result in an isolated contact with the globe. Contact with both the globe and the infraorbital rim would also more readily explain the extensive soft tissue herniation that often accompanies blow-out fractures.⁸

Kreidl and colleagues,⁵ reported that significant intraocular problems were detected in 29.3% of blow-out fractures, but intraocular injuries were more frequent in patients with severe orbital trauma without orbital fracture (58.9%). They believed that orbital fractures can offer a protective mechanism against intraocular injuries.⁵

Interestingly, we found less ocular injuries accompany with large orbital fracture that can mention to protective role of orbital fractures. Maybe it shows the importance of buckling mechanism in large fracture (no contact with globe). Wolfe¹⁷ proposed that if the fracture happened by direct contact with the globe, a greater number of globe ruptures would be resulted due to severe posterior displacement. Our finding is in accordance with Kreidl study.⁵ We found that intraocular injuries were less frequent in patients with more sever fractures.

Although we cannot individualize the consequences of these mechanisms and it seems they coexist in most fractures.

New belief is that mechanism of injury is a stronger predictor for eye injuries than fracture pattern, and that patients with specific injuries (like motor accidents) with different mechanisms, rather than specific fracture patterns, deserve higher ophthalmologic scrutiny.¹⁸ This hypothesis is not consistent with our findings.

This study supports the protective role of orbital blow-out fractures that lessen the amount of intraocular injury advocated by Kreidl et al.⁵

This study is limited by a relatively small sample size, in contrast to other studies.^{4,12,13} But except for Cook et al¹³ study, the remarkable point in our report is that, all patients were examined within the first day after trauma by a single ophthalmologist. Also, all clinical finding were recorded according to predetermined protocol.

Conclusion

Various types of intraocular injuries may happen in patients with orbital blow-out fracture, but; major ocular injuries are uncommon. Also, complete ocular examination should be performed in these cases, and the minority of which require immediate evaluation and treatment by an ophthalmologist.

References

1. Putterman AM, Stevens T, Urist MJ. Nonsurgical management of blow-out fractures of the orbital floor. *Am J Ophthalmol* 1974;77(2):232-9.
2. Liebsohn J, Burton TC, Scott WE. Orbital floor fractures: a retrospective study. *Ann Ophthalmol* 1976;8(9):1057-62.
3. Folkestad L, Westin T. Long-term sequelae after surgery for orbital floor fractures. *Otolaryngol Head Neck Surg* 1999;120(6):914-21.
4. 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(5):291-301.
5. Kreidl KO, Kim DY, Mansour SE. Prevalence of significant intraocular sequelae in blunt orbital trauma. *Am J Emerg Med* 2003;21(7):525-8.
6. Lim LH, Lam LK, Moore MH, Trott JA, David DJ. Associated injuries in facial fractures: review of 839 patients. *Br J Plast Surg* 1993;46(8):635-8.

7. Jayamanne DG, Iglie RF. Orbital blow-out fractures: long-term visual outcome of associated ocular injuries. *J Accid Emerg Med* 1995;12(4):273-5.
8. He D, Blomquist PH, Ellis E 3rd. Association between ocular injuries and internal orbital fractures. *J Oral Maxillofac Surg* 2007;65(4):713-20.
9. Bullock JD, Warwar RE, Ballal DR, Ballal RD. Mechanisms of orbital floor fractures: a clinical, experimental, and theoretical study. *Trans Am Ophthalmol Soc* 1999;97:87-110; discussion 110-3.
10. Rhee JS, Kilde J, Yoganadan N, Pintar F. Orbital blowout fractures: experimental evidence for the pure hydraulic theory. *Arch Facial Plast Surg* 2002;4(2):98-101.
11. Ashar A, Kovacs A, Khan S, Hakim J. Blindness associated with midfacial fractures. *J Oral Maxillofac Surg* 1998;56(10):1146-50.
12. Gossman MD, Roberts DM, Barr CC. Ophthalmic aspects of orbital injury. A comprehensive diagnostic and management approach. *Clin Plast Surg* 1992;19(1):71-85.
13. Cook T. Ocular and periocular injuries from orbital fractures. *J Am Coll Surg* 2002;195(6):831-4.
14. Converse JM: Discussion of: Fujino T, Makino K. Entrapment mechanism and ocular injury in orbital blowout fracture. *Plast Reconstr Surg* 1980;65(5):571-6.
15. Song WK, Lew H, Yoon JS, Oh MJ, Lee SY. Role of medial orbital wall morphologic properties in orbital blow-out fractures. *Invest Ophthalmol Vis Sci* 2009;50(2):495-9.
16. Park SH, Rah SH, Kim YH. Clinical evaluation of the associated ocular injuries of orbital wall fracture patients. *J Korean Ophthalmol Soc* 2002;43(8):1474-81.
17. Wolfe SA: Discussion of: Erling BF, Iliff N, Robertson B, Manson PN. Footprints of the globe: a practical look at the mechanism of orbital blowout fractures, with a revisit to the work of Raymond Pfeiffer. *Plast Reconstr Surg* 1999;103(4):1313-6; discussion 1317-9.
18. Magarakis M, Mundinger GS, Kelamis JA, Dorafshar AH, Bojovic B, Rodriguez ED. Ocular injury, visual impairment, and blindness associated with facial fractures: a systematic literature review. *Plast Reconstr Surg* 2012;129(1):227-33.