

Patterns and prognosis of commotio retinae in orbital wall fractures

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Abstract

Purpose: Orbital wall fractures are a significant cause of ocular injury in trauma and are associated with posterior segment pathology. This study aims to characterize patterns and prognosis of commotio retinae following orbital wall fracture.

Methods: This study is a retrospective analysis of 294 orbital wall fractures diagnosed by computed tomography imaging from August 2015 to October 2016 at a Level 1 trauma center. Dilated funduscopy exams were assessed for acute posterior segment pathology, focusing specifically on commotio retinae ($N = 38$). These were compared with patients with no traumatic retinal findings ($N = 253$) to indicate statistically significant differences in the mechanism of injury, fracture pattern, subjective symptoms, radiologic and exam findings, and acute interventions.

Results: Commotio was most commonly associated with assault (60.5%, $p = 0.004$) in a younger patient population, whereas normal retinal exams were more likely after falls from standing (24.1%, $p = 0.022$). Half of all commotio was found inferiorly and most commonly occurred in medial or inferior wall fracture. Patients with commotio were more likely to have motility deficits (29.7%, $p = 0.049$) with clinical evidence of entrapment (13.2%, $p < 0.001$), requiring acute operative repair (15.8%, $p = 0.005$). Inferior wall fracture was associated with 19.4% surgical intervention in commotio as compared with those with normal funduscopy exams (6.1%, $p = 0.012$). All patients with follow-up had resolution of commotio and best-corrected visual acuity of 20/25 or better.

Conclusion: Retinal pathology is not infrequent in orbital wall fractures. Inferior wall fracture was associated with 19.4% surgical intervention in commotio as compared to those with normal funduscopy exams (6.1%, $p = 0.012$). A high index of suspicion and thorough investigation is warranted in evaluating these patients.

Keywords: orbit, orbital fracture, retina

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Introduction

Head trauma can result in significant injury to the orbit, including orbital wall fracture. This is common due to the exposed nature of the orbital rim and thinness of the bony walls of the mid-face.¹ According to the literature, approximately one half of orbital fractures are isolated and confined to one wall of the orbit, primarily either the medial or the inferior wall.² To date, there are few studies looking at the rates and subsequent treatment patterns of retinal pathology with orbital wall fracture(s).³ For example, Kreidl and

colleagues found a 4.7% rate (6 of 127) of commotio retinae in their ‘severe’ group (those involving orbital wall fractures) of blunt ocular trauma patients, but they did not describe the treatment patterns of these patients or likelihood of operative intervention.

Commotio retinae, an opacification of the retina due to injury of the photoreceptor outer segments resulting from blunt ocular trauma^{4,5} has never been correlated to other concomitant ocular injuries or treatment patterns in orbital wall fracture.

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Our study aims to retrospectively analyze patients with orbital wall fractures and determine the rate of commotio retinae, consequent treatment plans, and long-term prognosis.

Materials and methods

This study is a retrospective review approved by the Institutional Review Board (IRB) of Brooke Army Medical Center (BAMC), Fort Sam Houston, San Antonio, TX (IRB approval no. C.2017. 123d). The study is HIPAA (Health Insurance Portability and Accountability Act of 1996) compliant and adhered to the ethical principles as outlined in the Declaration of Helsinki as amended in 2013. A database of medical records from BAMC, from August 2015 to October 2016, was searched. Records of any orbital wall fractures were included in the review. A total of 294 orbital wall fractures with subsequent dilated funduscopic exams (DFEs) were analyzed. All 294 patients met the following inclusion criteria: patient presented to BAMC Emergency Department and was diagnosed with a new orbital wall fracture by computed tomography (CT). Patients less than 18 years of age were excluded.

All patients underwent complete ophthalmic examination, including tonometry, pupillary assessment, best-corrected visual acuity (BCVA), slit-lamp biomicroscopy, and indirect ophthalmoscopy. In addition, patient demographics, time of injury, and causes of ocular trauma were recorded. CT scan was obtained during the BAMC Emergency Department visit. Measurements of visual acuity at follow-up were performed by trained personnel using a standard Snellen chart.

DFEs of patients with orbital wall fracture(s) were retrospectively assessed for acute posterior segment pathology, focusing specifically on commotio retinae ($N = 38$). Patients with commotio retinae were compared to patients with no traumatic retinal findings ($N = 253$), using independent t tests, Pearson's χ^2 test, and Fisher's exact test, to indicate a statistically significant difference in the mechanism of injury, fracture pattern, subjective symptoms, CT and exam findings, and acute interventions. Data obtained were assessed with descriptive statistics and frequency. A p value of less than 0.05 was considered statistically significant.

Results

Mean age was 45.2 ± 20.8 years; the majority were male (75.5%) (Table 1). Commotio

occurred in 12.9% of subjects ($N = 38$), with a mean age of 35.5 ± 13.9 years, significantly younger than patients with normal dilated exams (46.6 ± 21.3 , $p = 0.002$). Commotio was most commonly associated with assault (60.5%, $p = 0.004$), whereas normal retinal exams were more likely after falls from standing (24.1%, $p = 0.022$). About half (47.4%) of all commotio was found in isolated inferior wall fractures, with medial wall involvement being the second most likely isolated pattern (10.5%). Overall, 97.4% of patients with commotio had involvement of one or both of the inferior and medial walls. Isolated superior wall and lateral wall involvement occurred in 2.6% and 0% of commotio injuries, respectively (Table 1).

Location was documented in 36/38 patients with commotio. The inferior retina was the most common site (50.0%), followed by temporal (41.7%), nasal (25.0%), macula (22.2%), and superior regions (13.9%).

All cases of macular commotio ($n = 8$) occurred in fractures involving the inferior or medial wall, or both. The fracture site least commonly involved was the lateral wall (one out of eight cases).

Patients with commotio were more likely to have ocular motility deficits (29.7%, $p = 0.049$) with clinical evidence of muscle entrapment (13.2%, $p < 0.001$), necessitating more frequent acute operative repair (15.8% of commotio versus 4.4% of normal dilated exams, $p = 0.005$) (Table 1). If the inferior wall was involved, those with commotio were also more likely to require operative intervention (19.4%) compared with those without commotio (6.1%, $p = 0.012$).

In total, 55.3% of patients with commotio followed up for return care, with a mean follow-up of 19.3 days after discharge [range 7–40 days, 95% confidence interval (CI): 13.9–24.8, standard deviation (SD): 10.4]. All patients with follow-up ($N = 21$) had resolution of commotio and a BCVA of 20/25 or better, and 85.7% of patients had a BCVA of 20/20 or better. Of the eight patients with macular commotio, three were seen at follow-up and all three patients had a BCVA of 20/20 or better.

Discussion

This study demonstrates a 12.9% rate of commotio retinae with orbital wall fracture. This rate is

Table 1. Characteristics and interventions of eyes with orbital wall fracture and concomitant commotio retinae versus normal DFE. Commotio was associated with younger age, assault, clinical evidence of entrapment, motility deficit, and operative fracture repair, especially if the inferior orbital wall was involved.

Variable	Total DFEs (N = 294)	Commotio (N = 38)	Normal DFE (N = 253)	p Value
Age (mean ± SD)	45.2 ± 20.8	35.5 ± 13.9	46.6 ± 21.3	0.002
Sex, male, n (%)	222 (75.5)	29 (76.3)	190 (75.1)	0.871
Mechanism of injury, n (%)				
Assault	116 (39.5)	23 (60.5)	92 (36.4)	0.004
Ground-level fall	64 (21.8)	3 (7.9)	61 (24.1)	0.022
Fall from height	21 (7.2)	0 (0.0)	20 (7.9)	0.087
MVC/MCC	54 (18.4)	5 (13.2)	48 (19.0)	0.501
Other	39 (13.3)	7 (18.4)	32 (12.6)	0.314
Isolated wall fracture, n (%)				
Medial wall	41 (13.9)	4 (10.5)	36 (14.2)	0.537
Inferior wall	114 (38.8)	18 (47.4)	95 (37.5)	0.247
Lateral wall	12 (4.1)	0 (0.0)	12 (4.7)	0.377
Superior wall	13 (4.4)	1 (2.6)	12 (4.7)	0.557
Multiple walls	114 (38.8)	15 (39.5)	98 (38.7)	0.931
Both medial and inferior walls	60 (20.4)	10 (26.4)	49 (19.4)	0.321
Either medial or inferior wall	265 (90.1)	37 (97.4)	225 (88.9)	0.106
Associated injury, n (%)				
Entrapment (CT)	24 (8.2)	5 (13.2)	19 (7.5)	0.218
Entrapment (clinical)	9 (3.1)	5 (13.2)	4 (1.6)	<0.001
Retrobulbar hemorrhage	33 (11.2)	6 (15.8)	25 (9.9)	0.264
Both eye involvement	18 (6.1)	2 (5.3)	15 (5.9)	0.870
Signs and symptoms, n (%)				
Visual acuity decrease	49/262 (18.7)	10/35 (28.6)	39/225 (17.3)	0.114
Diplopia	29/262 (11.1)	5/35 (14.3)	24/225 (10.7)	0.527
Motility deficit	50/277 (18.1)	11/37 (29.7)	39/239 (16.3)	0.049
Oculocardiac reflex	5/275 (1.8)	2/38 (5.2)	3/236 (0.9)	0.088
Hyphema	5/294 (1.7)	1/38 (2.6)	4/253 (1.6)	0.642
APD	10/293 (3.4)	0/37 (0.0)	10/252 (4.0)	0.371
Corneal abrasion	18/294 (6.1)	2/38 (5.2)	16/253 (6.3)	0.800

(Continued)

Table 1. (Continued)

Variable	Total DFEs (N = 294)	Commotio (N = 38)	Normal DFE (N = 253)	p Value
Lid laceration	38/294 (12.9)	3/38 (7.9)	35/253 (13.8)	0.311
No subjective exam, n (%)	33 (11.2)	3 (7.9)	28 (11.1)	0.554
Intervention (total), n (%)	62 (21.1)	9 (23.7)	51 (20.1)	0.616
Ophthalmic medication	12 (4.1)	2 (5.2)	10 (4.0)	0.705
Orbit checks	12 (4.1)	0 (0.0)	11 (4.4)	0.370
Bedside procedure	25 (8.5)	1 (2.6)	24 (9.5)	0.160
Canthotomy/cantholysis	7 (2.8)	0 (0.0)	7 (2.8)	0.600
Operative repair (total)	17 (5.8)	6 (15.8)	11 (4.4)	0.005
Inferior wall involvement	17/201 (8.5)	6/31 (19.4)	11/170 (6.1)	0.012

APD, afferent pupillary defect; CT, computed tomography; DFE, dilated funduscopy exam; MCC, motorcycle crash; MVC, motor vehicle collision; SD, standard deviation. P value of less than 0.05 (bolded) was considered statistically significant.

higher than that previously described in the literature, with the rates of 4.7%,³ 8.8%,⁴ and 2.2%.⁵ To date, the rate of operative intervention in patients suffering from commotio retinae in orbital wall fractures has never been described. In our study, patients with commotio were greater than eight times more likely to display clinical evidence of entrapment (13.2% versus 1.6%), with greater rates of motility deficit, and were subsequently greater than three times more likely to require acute operative repair (15.8% versus 4.4%). These rates were even higher for commotio associated with inferior wall fracture. The reason for higher rates of entrapment requiring operative repair in patients with commotio is possibly the following: the force required to cause commotio likewise causes a larger fracture segment amenable to muscle belly entrapment. Less forceful impacts, with concomitantly smaller fractures and lower likelihood of muscle entrapment, are probably less likely to cause commotio.

Although we demonstrate a follow-up BCVA of 20/25 or better in patients with orbital wall fracture and concomitant commotio, patients with true macular commotio [as diagnosed by optical coherence tomography (OCT)], termed Berlin's edema, suffer from poor long-term visual acuity according to the literature.⁶ Chen and colleagues,⁷ with a sample size of 46 eyes, found an average BCVA of 20/110 at long-term follow-up. Another study published that year found more than 50%

of patients with Berlin's edema to have a follow-up BCVA of 20/200 or worse.⁸ Of our eight patients with macular commotio, three followed up in clinic; all had a BCVA of 20/20 or better and resolved commotio. Although we observed good visual acuity at follow-up, this is inconsistent with the literature and less than half of qualifying patients returned for follow-up.

Patients with macular commotio retinae should have a thorough workup with a retinal specialist and strict follow-up. Due to the high rates of commotio found in our study, diligence in completing a comprehensive ophthalmological exam, including DFE, is necessary in the evaluation of patients with orbital wall fracture(s). If the ophthalmologist is suspicious of Berlin's edema, macular OCT can appropriately diagnose the extent of retinal pathology such as outer photoreceptor disruption or edema within the outer nuclear layer.⁹ Macular OCT is thus a useful tool in both diagnosis and long-term follow-up of these patients.¹⁰

As demonstrated by this study, commotio retinae, an opacification of the retina secondary to blunt orbital trauma, occurs commonly in fractures of the orbit. Ultimately, we believe it is essential for all ophthalmologists to perform DFEs on patients with orbital wall fractures, recognizing that patients with injury to the posterior segment may be more likely to require surgical intervention. If the funduscopy exam is suspicious for macular commotio, OCT

should be utilized at initial visit for baseline diagnosis and at follow-up to monitor improvement.

Limitations of this study include those inherent in a retrospective study design. Also, all data were gathered from a single large academic center. In addition, all patients were adults over the age of 18. It is unclear whether similar rates of commotio retinae and concomitant ocular findings occur in the pediatric population. Another limitation to this study is that the primary data are based on DFEs of ophthalmology residents, which may under- or overestimate the presence of posterior segment pathology. However, we do not suspect this would affect the comparison of rates of commotio found in different patterns of orbital wall fracture.

Future directions include performing OCT exams on all patients with macular commotio retinae, both initially and at follow-up, regardless of their BCVA. This will better delineate the relationship between orbital wall fracture, macular commotio, optimal management, and visual prognosis.

Overall, this study affirms our belief that trauma surgeons and emergency room physicians should obtain consultation of the ophthalmology department when faced with a patient with an orbital wall fracture. The ophthalmologist should then perform a comprehensive dilated examination.

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