

Functional and anatomical outcome in closed globe combat ocular injuries

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Abstract

Objective: To analyse the pattern, visual and anatomical outcome of closed globe combat-related ocular injuries sustained by troops.

Methods: This retrospective study was conducted at Armed Forces Institute of Ophthalmology, Rawalpindi, Pakistan, and comprised patients with ocular injuries from January 2010 to June 2014. Record of each patient was evaluated and demography, mode and type of injury, initial and final visual acuity, associated globe injuries, concomitant non-ocular injuries, type of surgical procedures and complications were endorsed on a pre-devised proforma. Statistical analysis was done using SPSS 13.

Results: Overall, 49 eyes of 44 male participants were analysed. The overall mean age was 27.59±6.89 years. The most common mode of injury was improvised explosive device blast responsible for 22(50%) casualties. Ocular contusion was the most frequent closed-globe injury occurring in 35(71.42%) eyes. Most frequent ocular findings in all injured eyes were vitreous haemorrhage 16(32.65%), cataract 12(24.48%), retinal detachment 8(16.32%) and commotio retinae 8(16.32%). A total of 48(97.96%) intra-ocular/adnexal surgeries were performed with pars plana vitrectomy 17(34.69%), cataract surgery 16(32.65%), intraocular lens implantation 8(16.32%), and adnexal surgery 5(10.20%) being the most frequently performed procedures. Overall visual improvement at the final follow-up was statistically significant in all injured eyes irrespective of mode of treatment ($p=0.001$).

Conclusion: The functional and anatomical outcome was better in closed-globe combat ocular injuries compared to open-globe injuries.

Keywords: Ocular injuries, Combat, Visual outcome, Closed-globe injuries. (JPMA 66: 1582; 2016)

Introduction

Ocular injuries are classified into closed-globe and open-globe injuries according to the Birmingham Eye Trauma Terminology (BETT).¹ Combat-related ocular injuries pose a major socio-economic dilemma as they usually affect the young working force of the society, requiring prolonged treatment and rehabilitation. Although ocular surface measures only 0.1% of total and 0.27% of the anterior surface of body, the incidence of combat ocular injuries is disproportionately high varying from 0.65% - 13%.^{2,3} Blasts are a common mechanism of injury in military combat. Morley MG et al. in their review of explosive blast injuries from 1947-2007 found that 28% of blast survivors had ocular injuries.⁴ In the current era, the development of weapons with higher explosive and fragmentation power has resulted in increased severity and morbidity of warfare ocular injuries. Ocular blast injuries can be primary, secondary, tertiary or quaternary. Primary blasts generate a massive amount of kinetic energy, with shock wave propagating through various ocular mediums causing devastating injuries even at considerable distance, including concussive damage to

the eye and adnexa.^{5,6} Secondary blast injuries resulting from the impact of high-velocity shrapnel and metallic fragments or from exogenous debris propelled by blast are the commonest ocular injuries sustained during combat environment. Closed-globe injuries are common to both primary and secondary blast injury.³ The spectrum of combat ocular injuries varies from very mild, non-sight threatening to extremely serious with potentially blinding consequences.

Visual outcome in combat ocular injuries is variable and depends on the mode, mechanism and type of injuries, with closed-globe injuries usually having better visual outcome as compared to open-globe injuries. In a retrospective analysis of combat ocular trauma cases during operation Iraqi and enduring freedom, Weichel ED et al. reported overall final best corrected visual acuity (BCVA) of 6/12 or better in 42% of eyes, with closed-globe injury cases accounting for 65% of those cases.⁷ Factors associated with poor visual outcome include presenting visual acuity (VA) of no light perception (NLP) or light perception (PL), the presence of relative afferent pupillary defect (RAPD), central corneal opacity, retinal detachment (RD), endophthalmitis, macular scarring and optic atrophy.⁵ Published data on the pattern and characteristics of combat-related closed-globe ocular injuries is scarce. The current study was planned to

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analyse the demography, pattern, visual and anatomical outcome of closed-globe combat related ocular injuries sustained by troops during ongoing war on terror.

Patients and Methods

This retrospective study was conducted at the Armed Forces Institute of Ophthalmology (AFIO), Rawalpindi, Pakistan, and comprised cases of ocular injuries from January 2010 to June 2014 that were sustained by troops during the ongoing war on terror at the western borders of the country. Approval was obtained from the institutional ethical review committee. A combat ocular injury was defined as an ocular injury sustained from improvised explosive device (IED) blast, mine blast, bomb blast and gunshot wound. Patients with incomplete hospital record, open-globe ocular injury, history of previous ocular surgery, previous chronic ocular disease, e.g. glaucoma, uveitis or retinopathy, and follow-up of less than six months were excluded.

Record of each patient was evaluated and demographic data, the eye involved, mode and type of injury, initial and final Snellen VA, associated globe injuries, concomitant non-ocular injuries, type of surgical procedures and complications were endorsed on a pre-devised pro forma. Visual outcome was defined as poor if BCVA was < 6/60. Closed-globe injuries were classified as ocular contusion or lamellar laceration according to the BETT.¹ Superficial corneal foreign bodies (FB) were labelled as separate entity in closed-globe ocular injuries. Zones of eyeball injury were categorised on the criteria described by the Ocular Trauma Classification Group (OTCG), i.e. zone I (superficial injuries of bulbar conjunctiva, sclera and cornea), zone II (corneoscleral limbus to a point 5mm posterior into the sclera including violation of lens and anterior segment) and zone III (posterior to anterior 5mm of sclera including violation of the retina, vitreous, rear uvea and optic nerve).⁸

Statistical analysis of the data was done using SPSS 13. Descriptive statistics i.e. mean $\pm$ standard deviation (SD) for quantitative values and frequencies along with percentages for qualitative variables were used to describe the data. The association of various variables with final visual outcome was analysed using chi-square test/Fisher's exact test and $p < 0.05$ was considered significant. McNemar's test was used to analyse initial and final visual acuities.

Results

Overall, 49 eyes of 44 male participants were analysed. Right eye was involved in 18(40.91%) patients and left eye in 21(47.72%) cases while bilateral involvement occurred

Table-1: Demographic and clinical characteristics of the study population.

Characteristic	No (%)
Eye Involved (n=44)	
Right	18 (40.91%)
Left	21 (47.72%)
Bilateral	5 (11.36%)
Mode of Injury (n=44)	
IED blast	22 (50%)
Mine blast	10 (22.72%)
Bomb Blast	7 (15.90%)
Gunshot	5 (11.36%)
Closed Globe Injury (n=49) *	
Contusion	35 (71.42%)
Lamellar laceration	3 (6.12%)
Corneal Foreign body	19 (38.77%)
Zone of Injury (n= 49) *	
Zone I	23 (46.93%)
Zone II	8 (16.32%)
Zone III	25 (51.02%)
Concomitant Injuries (n=18) *	
Face	14 (77.77%)
Limbs	10 (55.55%)
Chest	8 (44.44%)
Head	3 (16.66%)
Abdomen	2 (11.11%)

*The occurrence of multiple manifestations simultaneously accounts for the % distribution of > 100%.

IED: Improvised explosive device.

in 5(11.36%) patients. Besides, 17(38.63%) patients had concomitant open globe injury in other eye. The overall mean age was 27.59 ± 6.89 years (range: 20-50 years), with 31(72.09%) patients in their 3rd decade of life. The most common mode of injury was IED blast responsible for 22(50%) casualties. Also, 18(40.90%) patients sustained concomitant non-ocular injuries as well; of them, 14(77.77%) injuries were related to face and 10(55.55%) to limbs. As for the zone of injury, 25(51.02%) of the 49 eye injuries fell into zone III, 23(46.93%) into zone I and 8(16.32%) into zone II, with 7(14.28%) eyes had involvement of more than one zone. The use of internationally recommended protective eye gear at the time of injury was not documented in any case. Ocular contusion was the most frequent closed globe injury occurring in 35(71.42%) eyes (Table-1).

The most frequent ocular findings in all injured eyes were vitreous haemorrhage 16(32.65%), superficial corneal FB 14(28.57%), cataract 12(24.48%), RD 8(16.32%) and commotio retinae 8(16.32%) (Figure).

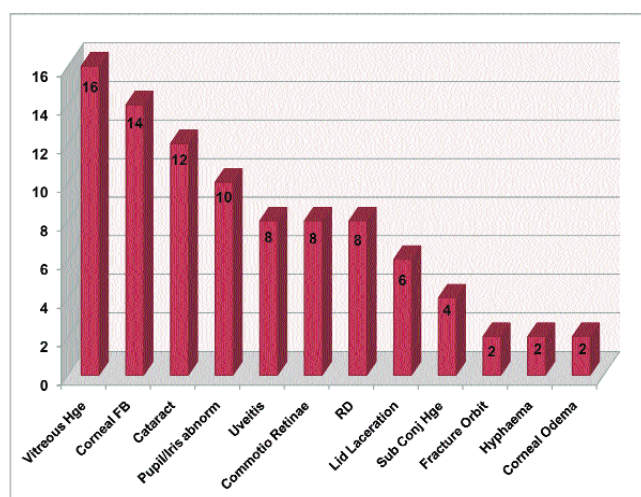
Moreover, 26(53.06%) eyes were initially managed conservatively that included removal of superficial corneal FBs. A total of 48(97.96%) intra ocular/adnexal

Table-2: Initial and Final Visual Acuities.

BCVA	Conservative Treatment (n=26)		Surgical Treatment (n=23)		Total (n=49)	
	Initial VA	Final VA	Initial VA	Final VA	Initial VA	Final VA
≥ 20/40 (6/12)	12 (46.15%)	19 (73.07%)	2 (8.69%)	7 (30.43%)	13 (26.53%)	26 (53.06%)
20/50 - 20/100 (6/15 - 6/30)	4 (15.38%)	2 (7.69%)	-	3 (13.04%)	4 (8.16%)	5 (10.20%)
20/120 - 20/200 (6/36 - 6/60)	4 (15.38%)	-	1 (4.34%)	4 (17.39%)	6 (12.24%)	4 (8.16%)
< 20/200 (< 6/60)	6 (23.07%)	5 (19.23%)	20 (86.95%)	9 (39.13%)	26 (53.06%)	14 (28.57%)

BCVA: Best corrected visual acuity

VA: Visual acuity.



Hge: Haemorrhage. FB: Foreign bodies. RD: Retinal detachment.

Figure: Ocular manifestations of Combat Ocular Injuries.

surgeries were performed with a few eyes requiring multiple surgeries. Pars plana vitrectomy (PPV) with or without internal temponade was done in 17(34.69%) eyes. Other commonly performed surgical procedures included cataract surgery in 16(32.65%) eyes, intraocular lens (IOL) implantation in 8(16.32%) eyes, and adnexal surgery in 5(10.20%) eyes. Complicated cataract 8(16.32%), corneal opacity 6(12.24%) and proliferative vitreo retinopathy (PVR) with persistent RD 4(8.16%) were the most frequently encountered ocular complications. Other less frequently observed complications included secondary glaucoma and choroidal detachment in 2(4.08%) eyes each, and optic neuropathy and endophthalmitis in 1(2.04%) eye each. Maculopathy (macular scar, macular pucker, epiretinal membrane and macular hole) eventually developed in 10(20.40%) eyes.

Overall visual improvement at the final follow-up was statistically significant in all injured eyes irrespective of

mode of treatment ($p=0.001$). There was strong positive correlation between initial and final BCVA, and was statistically significant ($p=0.001$). There were 5(19.23%) eyes with conservative treatment and 9(39.13%) eyes with surgical treatment that had poor visual outcome (BCVA <6/60) ($p=0.205$) (Table-2).

Factors significantly associated with poor visual outcome were maculopathy ($p=0.022$), PVR with persistent RD ($p=0.005$), zone III injury ($p=0.004$) and presenting VA of < 6/60 ($p=0.000$). Concomitant non-ocular injuries ($p=1.0$), corneal opacity ($p=1.0$) and mode of treatment ($p=0.205$) did not show a significant association with poor visual outcome.

Discussion

Urbanisation and modernisation of warfare with development of weapons having higher explosive and fragmentation power has resulted in increased severity and morbidity of warfare ocular injuries over the last few decades. Closed-globe injuries in combat environment are less common than open-globe injuries and usually have better anatomical and functional outcome. The incidence of closed-globe injuries ranging from 20% to 43% and open globe injuries from 29.6% to 80% had been reported in various studies on combat ocular trauma.^{5,9-12} In comparison to domestic ocular injuries, combat ocular injuries are usually more severe, bilateral, and often accompanied by concurrent systemic injuries and poor visual outcome. War injuries differed significantly from domestic injuries as there was more male involvement (84.7 vs. 75.1%), more adult involvement (72.7 vs. 39.1%), more bilateral ocular involvement (19.3 vs. 4.4%), more systemic injury (43.7 vs. 10.1%) and less visual improvement (28.6% vs. 44.8%).¹³ In our study, all the victims were males with a mean age of 27.59 ± 6.89 years. A significant male preponderance of more than 90% with mean ages between 23.43-29.5 years was reported in various other studies on combat ocular trauma.^{5,6,9-12} Due to higher explosive and fragmentation power of modern

warfare weapons, combat ocular injuries are often bilateral. In our study, 5(11.36%) patients had bilateral closed-globe injuries, while another 17(38.63%) patients had concomitant open-globe injury in the other eye. Reported incidence of bilateral combat ocular injuries varies from 10.87% to 56% in literature depending upon the mode and type of injuries.^{5,9-10,14} Alam M et al.¹⁵ and Philips BN et al.⁶ in their study on closed-globe combat ocular injuries reported 36.70% and 45% cases of bilateral ocular injuries. Collateral damage is a part and parcel of war trauma, and 18(40.90%) of our patients had concomitant non-ocular injuries, with face (31.81%) and extremities (22.72%) being the most commonly involved areas. There was quite a high proportion of concomitant non-ocular injuries varying from 67%-85%, with extremities and face being the most affected areas.^{7,9,16} Concomitant non-ocular injuries were not found to be significantly associated with poor visual outcome as reported in various studies, which coincides with our results.^{7,9} IED blasts were responsible for ocular injuries in 50% of our patients. Owen BD et al. in an analysis of a large cohort of wounded combatants found gunshot wound, IED, landmines, mortar or shrapnel, bomb, grenade and motor vehicle collision as the most frequent mechanism of injury, with IED blast accounting for 38% of cases.¹⁷ IED blasts as the causative agent for combat ocular trauma was reported in 58.3-86% of cases in various other studies.^{6,10,12} Zone of injury has a significant bearing on the long-term prognosis and final visual outcome. In our study 25(51.02%) eyes had zone III injury that was significantly associated with poor visual outcome. Weichel Ed et al.⁷ and Erduram FC et al.⁹ reported zone III involvement in 55.98% and 58.33% of eyes, respectively, while Gundogan FC et al.¹² found zone I involvement in 50% of eyes with closed-globe combat ocular injuries. Vlasov A et al.¹⁰ in their work reported zone III involvement in 97.2% of closed globe injuries that had led to more surgeries but often yielded disappointing visual results. Vitreous haemorrhage and cataract were the most frequent ocular manifestations of ocular injuries in our study. Alam M. et al. in their study on non-penetrating eye injuries in blast victims reported vitreous haemorrhage (38.88%), cataract (16.17%) and RD (7.35%) as the most frequent ocular manifestations.¹⁵ Blast injuries typically result in peppering of the conjunctival and corneal surface with minute foreign bodies that include metallic particles, gun powder, dust and sand. Superficial corneal FBs were found in 14(28.57%) eyes in our study. GC Cockerham et al. in their study reported ocular surface injuries in 255 of blast exposed patients with closed-globe injuries.¹⁸ Blanch RJ et al. in a retrospective analysis of ophthalmic injuries in British

armed forces involved in combat operations found superficial corneal FBs in 9(24.32%) eyes with closed globe injuries.¹⁹

Fortunately, a vast majority of closed-globe combat injuries can be managed conservatively with favourable functional and anatomical outcome. In our study, 26(53.06%) eyes were initially managed conservatively. In another study on non-penetrating eye injuries in bomb and mine blast victims, conservative management was done in 83.82% of eyes.¹⁵ Surgical treatment was required in 23(46.93%) eyes in our study population, with PPV and cataract surgeries being the most frequently performed procedures. Another study on blast victims also reported PPV and cataract extraction as the most frequently done surgical procedures.¹⁵ In another study, surgical treatment was required in 10(27.02%) eyes having closed-globe combat injuries with an average of 1.20 operations per eye.¹⁹

Final visual outcome in patients with combat ocular trauma is variable depending upon the type of injury, presenting visual acuity and presence or absence of ocular complications. In our study, 53.06% of eyes had presenting VA of $< 6/60$, but appropriate management resulted in final visual outcome of $\geq 6/12$ in 26(53.06%) eyes with only 14(28.57%) eyes had final BCVA of $\leq 6/60$ ($p=0.000$). Final visual outcome of $\geq 6/12$ had been reported in 58.82% to 65% eyes, whereas poor visual outcome (BCVA $\leq 6/60$) was reported in 21.1% to 29.6% eyes with closed-globe combat ocular injuries.^{5,7,10,15} Maculopathy and PVR with persistent RD was associated with poor visual outcome in our study. Macular scarring/hole, optic neuropathy, RD, choroidal haemorrhage, globe perforation, central corneal opacity, endophthalmitis and the presence of afferent pupillary defect have been identified as poor prognostic factors in ocular war injuries.⁵⁻⁷

A wide variation in setting of combat ocular injuries, i.e. mode, mechanism and type of injuries, results in quite differing statistics from various study populations. One of the limitations of the current study was its retrospective nature with some information often missing from the records, such as pupillary light reaction and zone of injury and associated complications.

Conclusion

The functional and anatomical outcome was better in closed-globe combat ocular injuries compared to open-globe injuries. However, appropriate identification of ocular damage and timely management is mandatory to reduce the morbidity associated with such injuries.

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Conflict of Interest: None.

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