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Visual outcome of closed globe injury due to shotgun pellet

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Abstract

Purpose: To characterize closed globe injuries due to pellets and determine prognosis of such injuries.
Methods: It was a prospective observational study and was carried between July 2016 and Jan 2018. About 253 eyes of 249 patients were included in the study. Injuries were classified in accordance with BETT (Birmingham Eye Trauma Terminology) terminology and Ocular Trauma Classification System as shown in and significance was determined for this classification.
Results: Majority of 163 (65.5%) patients was in the age group of 17-26 years and of246 (98.8%) patients were males. Most common presenting grade of vision was Grade A in 36.7% of eyes while most common type of injury was type A (Contusions) in 53%. Most common zone of injury was Zone I in 40.7%. Subconjunctival hemorrhage was most common ocular finding in 179 (70.7%) eyes followed by hyphema in 97 (38.3%) eyes. Visual outcome was found to be 6/36 or better in 226 (89.3%) of eyes. At the end of the study macular hole was present in 2 eyes, pseudophakia in 1, and cataract in 5, and distortion of foveal contour due to epiretinal membrane in 3, some macular scarring in 7, and RD in 2 eyes.
Conclusion: Zone III involvement need of vitrectomy, non-perception of light and relative afferent pupillary deficit at presentation is associated with poor outcome. Interventions in form of medical and surgical modalities significantly improve outcome.
***Keywords*:** ocular trauma, eye injury, closed globe, shotgun, pellet, visual outcome.

1. Introduction

Ocular trauma constitutes major and preventable cause of ocular morbidity and is leading cause of monocular blindness [1]. Ocular shotgun injuries represent small subset of ocular trauma and occur with low frequency. First used in response to the civil unrest in Northern Ireland in the 1970s, use of pellet guns in Kashmir (India) to control protesting mobs has emerged as a significant cause ocular morbidity in this part of world over the last few years. The guns used in Kashmir to curb agitated mob, the region of the study, is 12 Bore Pump Action Shotgun (commonly known as riot gun) with shot type 8/9 [2]. A 8 number shot contains approximately 410 pellets of 2.26mm diameter per 1 Oz while number 9 contains 585 pellets of 2.01mm diameter per Oz [3]. For both these very small size pellets, what matters is the distance from which the pellet guns are fired. Pellets as cause of injury are unique in that they cause mostly perforating injuries which have worse prognosis than other types of ocular injuries. Morris and coworkers [4] reported that in 22 patients with perforating shotgun injuries, 43% had a final vision of no light perception. The ability of shotgun pellets to perforate or damage the globe depends on the energy with which they strike the globe. This, in turn, is related to many different factors, including distance, temperature, powder load, shot size, shot weight, and gauge. Velocity decreases with increasing range and decreasing size of shotgun pellets that in turn may also leads to closed globe injuries. This study was prompted by the fact that for the past 8 years such injuries are now a frequent presentation of ocular trauma in our emergency rooms and past studies on ocular trauma do not take account of such injuries separately but together with other mechanisms of ocular trauma. Also, most of previous studies emphasized on open globe injuries. The purpose of this study is to characterize closed globe injuries due to pellets and determine prognosis of such injuries in view of modern treatment modalities.

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2. Materials and Methods

The study was approved by Ethical Committee of Government Medical College, Srinagar, India. The study was carried in complete agreement with the Declaration of Helsinki [5]. It was a prospective observational study. The duration of study period was one and half year and was carried between July 2016 and Jan 2018. Of 643 patients who reported with ocular trauma due to pellet during this period, 253 eyes of 249 patients were included in the study. Patients with previous history of surgical intervention or trauma or any ocular disease which may affect the visual outcome like glaucoma, cataract, hereditary fundus disorders, retinal detachments, diabetic or hypertensive retinopathy, ARMD (age related macular degeneration), retinal vascular occlusion, corneal dystrophies, corneal scars, keratoconusetc were excluded from the study. Patients with ocular injury due to causes other than shotgun pellet or with open globe injury were also excluded from study. After careful history taking all the patients did undergo following examination and investigations for both eyes in that order;

1. Visual acuity testing.
2. Swinging flash light test for presence or absence of RAPD (relative afferent pupillary deficit).
3. Slit lamp examination.
4. Fundus examination when permitted by media.
5. CT (Computed tomography) scans for detection and localization of foreign body.
6. B-scan in selected cases.
7. Surgical exploration under microscope where diagnosis of open and closed globe injury was in dilemma as shown in Figure 1.

Injuries were classified in accordance with BETT (Birmingham Eye Trauma Terminology) [6] terminology (Figure 2**)** and Ocular Trauma Classification System [7] as shown in Table1and significance (*P*-value) was determined for this classification.

Figure 1. Superficial subconjunctival foreign body

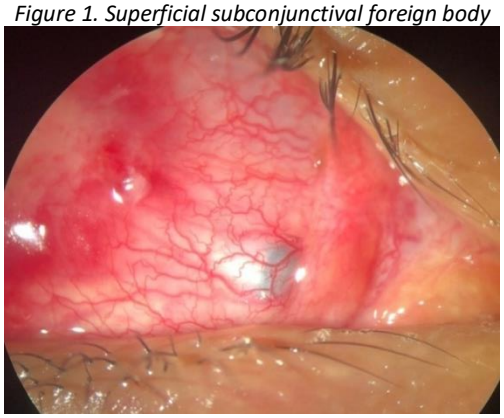
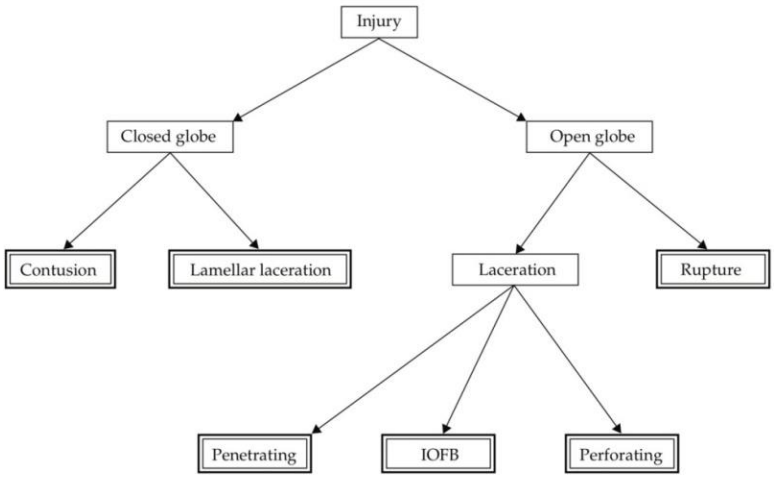


Figure 2. BETT Double frame boxes represent diagnosis used in clinical practice



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Closed globe injuries were managed conservatively and observed closely. Vitrectomy was carried in closed globe injuries when indicated like non-resolving or dense vitreous hemorrhage, retinal breaks, retinal detachment, macular hole, traumatic cataract, refractory hyphema, and traumatic subluxation or dislocation of lens etc.

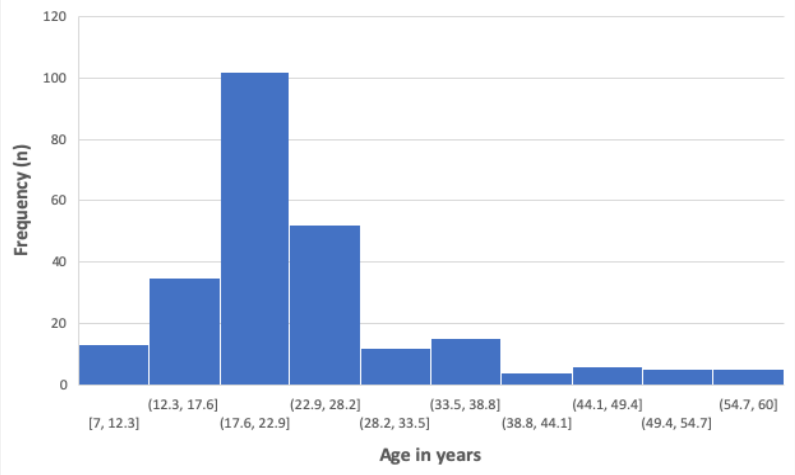
Table 1. OTC of closed globe injury

Type	*Type*
A	Contusion
B	Lamellar laceration
C	Superficial foreign body
D	Mixed
Grade	*Visual acuity*
A	>=20/40
B	20/50 to 2/100
C	19/100 to 5/200
D	4/200 to light perception
E	No light perception
Pupil	*Reactivity to light*
A	Positive, relative APD in injured eye.
B	Negative, no relative APD in injured eye.
Zone	*Location of injury*
I.	External (limited to bulbar conjunctiva, sclera, cornea)
II.	Anterior segment (includes structures of the anterior segment and the pars plicata)
III.	Posterior segment (all internal structures posterior to the posterior lens capsule)

Patients were followed up at 1 week, 1 month, 3 months and 6 months from time of injury. The following examination and investigations were done at each follow up.

1. Best corrected visual acuity.
2. Slit lamp examination for status for anterior chamber and lens.
3. Fundus examination for status of retina and media.
4. Intra-ocular pressure measurements.
5. OCT (optical coherence tomography) and FFA (fundus flouresciene angiography) in selected cases.

Figure 3. Age distribution of patients



The data was analyzed using standard statistical methods. Categorical variables were summarized as frequencies and percentages while continuous variables as mean and SD (standard deviation). The relative improvement of visual acuity after treatment was interpreted by applying paired two tailed t-test.

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Prognostic significance of other variables was calculated using Chi square and chi square for linear trend tests, for two dependent outcome variable of Good outcome (defined here as BCVA of1/60 or better) and Poor outcome (defined here as BCVA of worse than 1/60).

3. Results

The mean age of patients was 23.6±9.48 years (median age was 22 years) with range of 7-59 years. Majority 102 (40.9%) of patients were in the age group of 17.6-22.9 years (Figure 3). Most our patients 246 (98.8%) were males and 3 (1.2%) of our patients were females. In terms of laterality, 245 (98.4%) patients had only one injured with almost equal rate of right and left eye involvement and 4 (1.6%) patients had bilateral ocular trauma. Classification of injuries according to Ocular Trauma Classification in shown in Table 2 most common presenting grade of vision in eyes with closed globe injury was Grade A in 36.7% of eyes while most common type of injury was type A (Contusions) in 53%. Most common zone of injury was Zone I in 40.7%.

Table 2. Showing grade, type and zone of injury of closed globe injury in study eyes.

		Final VA≥1/60	FinalVA<1/60	Total	p-Value
Grade	*Grade A*	93(100%)	0	93	<0.0001 (Chi-square for linear trend)
	Grade B	59 (98.3%)	1 (1.7%)	60	
	Grade C	32 (88.8%)	4 (11.2%)	36	
	Grade D	53 (88.3%)	7 (11.7%)	60	
	Grade E	1(25%)	3 (75%)	4	
Type of Injury	*Contusion*	126 (94%)	8 (6%)	134	
	Lamellar Laceration	44 (93.6%)	3(6.4%)	47	
	Superficial Foreign Body	56 (94.9%)	3 (5.1%)	59	
	Mixed	12 (92.3%)	1(7.7%)	13	
Zone	*Zone I*	103(99%)	1(1%)	104	
	Zone II	53 (94.6%)	3 (5.4%)	56	
	Zone III	84 (88.4%)	11 (11.6%)	95	

Table 3.Showing frequency of clinical findings at presentation

	Frequency (n)	Percentage (%)
Hyphema any degree	97	38.3
Hyphema less than half chamber	52	
Hyphema half chamber	39	
Hyphema full chamber	6	
Traumatic cataract	3	1.2
Iridodialysis	9	4.3
Traumatic mydriasis	17	6.7
SCH	179	70.7
Subconjunctival FB	59	23.3
Retinal break	11	4.3
Vitreous Hemorrhage	58	22.9
Retinal detachment	4	2
Retinal edema	12	4.7
Retinal necrosis	2	0.7
Subretinal hemorrhage	21	8.3
Preretinal hemorrhage	1	0.4
Intraorbital foreign body	68	26.9
Periorbitalchemosis with or without entry wound	113	44.7
Periorbital foreign body	71	28
Eye lid tear	4	1.6

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Clinical features at presentation are shown in Table 3. Subconjunctival hemorrhage was most common ocular finding in 179 (70.7%) eyes followed by hyphema in 97 (38.3%) eyes. Most frequent posterior segment finding was vitreous hemorrhage and was present in 58 (22.9%) of eyes with closed globe injury as shown in Figure 4-5. Visual outcome at six months follow up was found to be better than or equal to 6/12 in 208 (82.2%) of eyes while no light perception was found in 2 eyes (Figure 6).

Figure 4. Fund us photo of traumatic cataract and corresponding OCT image

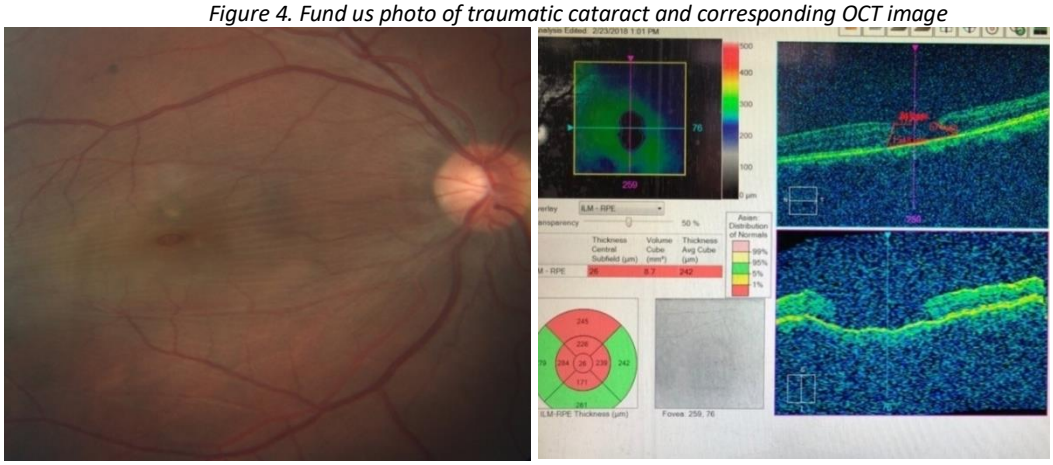


Figure 5. Vitreous hemorrhage (Zone III closed globe injury

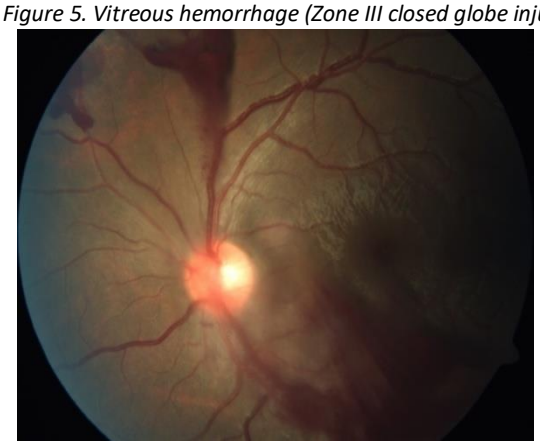
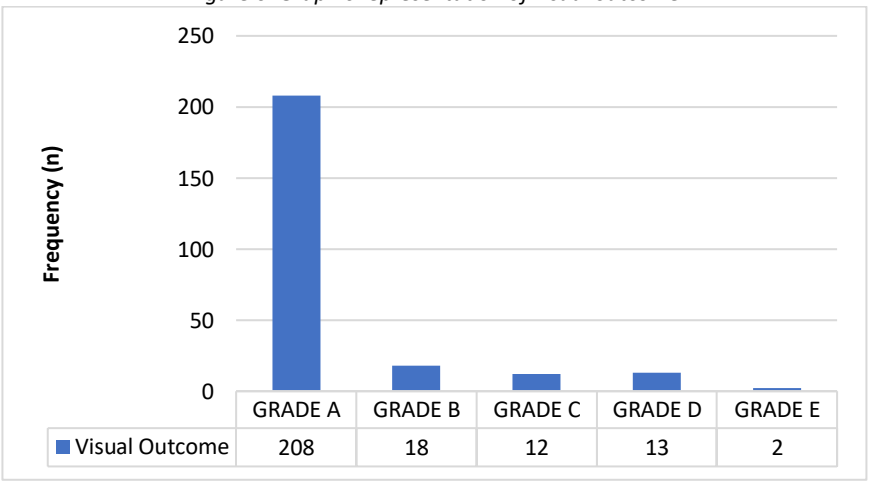


Figure 6. Graphic representation of visual outcome



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4. Discussion

There have been several reports on penetrating eye injuries due to pellet guns which operate on pressurized air [8-15]. To our knowledge, there are very few studies related to powdered pellet guns and no similar report on closed globe injuries from the cause. In a report of 140 patients with ocular injuries from air guns from the United States by [16] the mean age of patients was only 13 years. In contrast mean age in this series was 23.6±9.48 years. Older age group in our study represents the fact that these injuries were sustained during demonstrations, so due to deliberate actions.

In our study 98.8% of patients were males which indicate that mostly young males participate in these demonstrations in the region of our study. Unlike this series in a review of 202 cases of penetrating eye injury have reported a 4.66 to 1 male to female ratio of 105 cases with pellet gun injuries from England have reported a 7.5:1 male to female ratio. Visual outcome in this study was found to be 6/36 or better in 226 (89.3%) of eyes. In a report of 39 eyes with closed globe injury due to fireworks 90.5% of eyes had final visual outcome of 6/36 or better [17]. 25G Pars planavitrectomy was carried in 25 patients for indications mentioned in Table 4. Visual outcome for these eyes was worse than those eyes which did not undergo vitrectomy (Table 5). One eye with anterior detachment was managed by scleral buckling and had final visual acuity of 6/12. Cataract extraction with IOL implantation was done in one patient.

Table 4.Indication for vitrectomy

Indication	Number of eyes
Persistent or significant VH	25
Retinal breaks	8
RD	3
Others	1

For closed globe injuries Zone III involvement, need of vitrectomy, non-perception of light and relative afferent pupillary deficit at presentation were only finding found to be statistically significant (p-Value <0.0001) to adversely affect final outcome. At the end of the study macular hole was present in 2 eyes, pseudophakia in 1, and cataract in 5, and distortion of foveal contour due to epiretinal membrane in 3, some macular scarring in 7, and RD in 2 eyes. Grade of vision at presentation significantly correlated to visual outcome that in agreement to various studies on ocular trauma as shown in Figure 7.

Table 5. Visual outcome of eyes which underwent vitrectomy

Grade of visual outcome	Number of eyes
Grade A	6
Grade B	4
Grade C	5
Grade D	9
Grade E	1

Orbital pellets were seen in 131 patients while in 1 patients pellet travelled to brain parenchyma which we believe got there via orbital fissure in one patient and via chip fracture made by it in another patient. About 90% of lead in the body is stored in the bones for as long as 30 years, a period during which it can cause systemic and ocular toxicity [18]. Although lead poisoning can affect all the systems and cause a very wide range of morbidities in the body, the most common systemic effect is arterial hypertension. Ocular manifestations of lead poisoning include optic neuritis, nyctalopia, and cataract genesis. Optic neuritis is the most common ocular manifestation. A study published by Fox and Kats has shown that lead can increase rod outer segment calcium concentration, decrease rhodopsin content per eye and consequently end up in night blindness confirmed on electroretinogram as reduction in scotopica and b waves. Albeit we have not found any manifestations of lead poisoning in our patients at the end of six month follow up that can be attributed to lead poisoning. To detect same longer follow up is required probably a decade or two.

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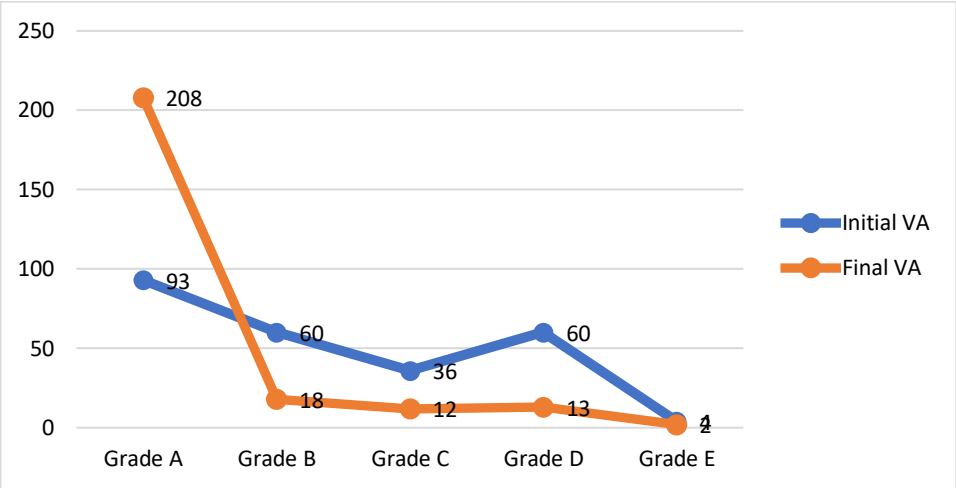
Figure 7. Comparison between presenting and final vision



5. Conclusion

Closed globe injuries due to pellets have better prognosis open globe injuries from same cause and blunt injuries from other mechanisms. Zone III involvement need of vitrectomy, non-perception of light and relative afferent pupillary deficit at presentation are associated with poor outcome. Interventions in form of medical and surgical modalities significantly improve outcome.

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