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Original Research Article

Prognostic Factors in Paediatric Open Globe Injuries

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Abstract:

Background: Ocular trauma is a major cause of monocular visual loss among children. The epidemiology and clinical characteristics of paediatric ocular trauma vary in different geographical locations. Various prognostic factors for final visual outcome in paediatric open globe injuries has been described by many investigators. At present, not many studies in this regard have been reported from the region where our study was conducted. The knowledge about prognostic factors give the clinician valuable inputs for counseling parents regarding the probable visual outcome that can be expected in these children.

Objectives: To determine the clinical features and visual outcome in traumatic open globe injuries in children and to identify the factors contributing to a poor visual outcome.

Methods: We conducted a retrospective study of 58 eyes of 58 consecutive patients aged less than 15 years with open globe injury over a period of 8 years. The baseline demographic data, details regarding the mechanism of injury, ocular findings at presentation including initial visual acuity and complications encountered were noted from patient records. The final visual outcome at 6 months and the factors affecting it were analysed using appropriate statistical tests.

Results: This study was conducted on 58 paediatric patients with open globe injury. Open globe injury was seen more in males [79.3%] and most of them were under 10 years of age [53%]. Penetrating injury was found to be the most common mechanism of injury [93.1%]. Injury with household objects while playing was present in 72.4% of which majority were sharp objects like scissors and knives. Majority of our patients had injury in Zone 1(cornea) [69%]. A poor final visual acuity <20/200 at 6 months was found in 23 patients (39.7%). Initial visual acuity[p<0.001], wound location[p=0.021] and wound length[p=0.001], traumatic cataract[p<0.001], retinal detachment[p=0.021], endophthalmitis [p=0.005], posterior segment involvement[p=0.005] and presence of globe rupture[p=0.021] were found to be statistically significant in determining the final visual outcome[p < 0.05] on univariate analysis. On further analysis using binary logistic regression, factors like having wound length > 10 mm {AOR=32.128 (p=0.024)}, presence of traumatic cataract {AOR=43.413 (p=0.008)}, endophthalmitis {AOR=131.192 (p=0.031)} and central corneal opacity {AOR=14.395(p=0.049)} were the independent predictors of final visual outcome in the study population. Among the factors predisposing to endophthalmitis in these patients it was found that found that injury with organic matter and contaminated wounds were most likely to develop endophthalmitis[p=0.012].

Conclusion: In our study we found that penetrating injury is the most common type of open globe injury in children less than 15 years of age. Majority of children suffered injuries with household objects. The presence of factors like wound length > 10 mm, traumatic cataract, endophthalmitis and central corneal opacity were the independent predictors of final visual outcome. The knowledge about these prognostic factors will aid the ophthalmologist in proper counseling of parents of such children. This also stresses the importance of improving parental awareness regarding eye trauma and adopting appropriate measures to avoid domestic accidents.

Keywords: Eye Injury, Open Globe Injury, Poor Final Visual Acuity, Traumatic Cataract, Zone of Injury, Endophthalmitis, Corneal Opacity.

Introduction

Ocular trauma is a major cause for visual morbidity and disability around the world. Of all ocular injuries, 22%–52% are estimated to occur in children and are a major cause of monocular blindness in this age group [1] It's impact on the child, family and the society at large needs our careful consideration. Open globe injuries are characterised by a full thickness breach of the eye wall (cornea/ sclera /both) and associated intraocular damage. The challenges encountered by the clinician are manifold in this scenario – a proper history regarding the mode of injury may

not always be forthcoming especially in small children and a thorough initial clinical examination may be difficult. The need for surgical treatment in most cases and the prolonged post-operative follow up is a challenge. In addition, allaying parental fear and anxiety and conveying a reasonably accurate prognosis on a case-based approach also falls into the hands of the treating surgeon. In this study we endeavor to describe the various factors that determine the visual prognosis in paediatric open globe injuries.

Materials and Methods

Ethical Approval

This study was approved by Institutional review board of a tertiary eye care centre in South India and complied with the tenets of the Declaration of Helsinki. We conducted a retrospective study of 58 eyes of 58 consecutive patients aged less than 15 years with open globe injury who presented to the Department of ophthalmology of a tertiary hospital in South India over a period of 8 years. The baseline demographic data, details regarding mode and mechanism of injury and time of presentation to hospital were noted from hospital records. Initial visual acuity was recorded in all possible cases. The location of the wound, its extent, associated hyphema, traumatic cataract, RAPD, vitreous hemorrhage; retinal detachment, intraocular foreign body, endophthalmitis etc were noted.

The injuries were classified as per the Birmingham Eye Trauma Terminology system (BETT) [2].

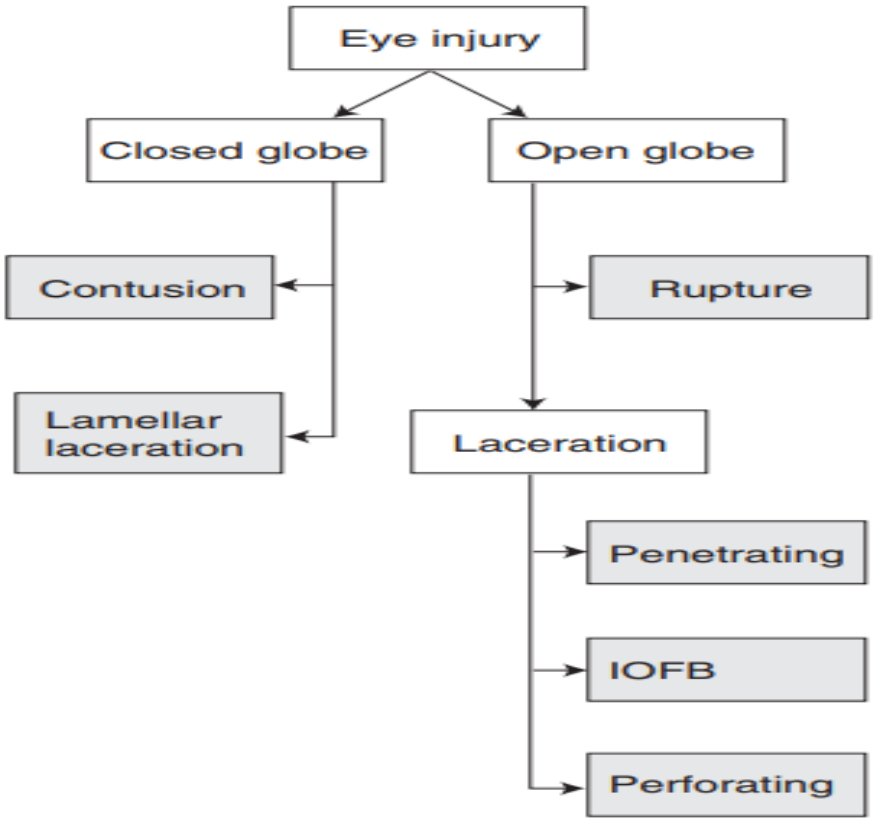

Figure 1: BETT Classification

The wound location was classified as three zones [2]

- Zone 1- Cornea
- Zone 2- Limbus and sclera up to 5mm posterior to limbus.
- Zone 3- Posterior to zone 2.

In case of injuries involving multiple zones the posterior most location will be considered. All patients underwent primary surgical repair under general anaesthesia at our centre. Corneal wounds were sutured with interrupted 10-0 nylon sutures and scleral wounds were sutured with 8-0 vicryl sutures.

All patients were treated postoperatively with intravenous broad spectrum antibiotics and topical broad spectrum antibiotic eye drops, cycloplegics and other supportive measures. Ocular imaging was done in all cases.

The details of primary surgical procedure, subsequent surgical procedures and complications were noted. The visual acuity recorded at 6 months follow up was taken as the final visual acuity. A

final visual acuity <20/200 was considered as poor visual outcome in our study.

The collected data was coded and entered in Microsoft Excel and analyzed using SPSS VERSION 25. The association between qualitative variables was analysed using Chi-square test and Fisher's exact test.

Significance was set at a p value less than 0.05. Those factors which were found to have a statistically significant association with final visual outcome ($p<0.05$) in univariate analysis were further analyzed using binary logistic regression and results estimated.

Results

In this study 58 eyes of 58 consecutive paediatric patients with open globe injury were analysed. All were single eye injury and surgical repair was done at our centre. Among them, 22.4% [n=13] were <5 years of age, 34.5% [n=20] were 5-10 years, 43.1% [n=25] were >10 years of age.

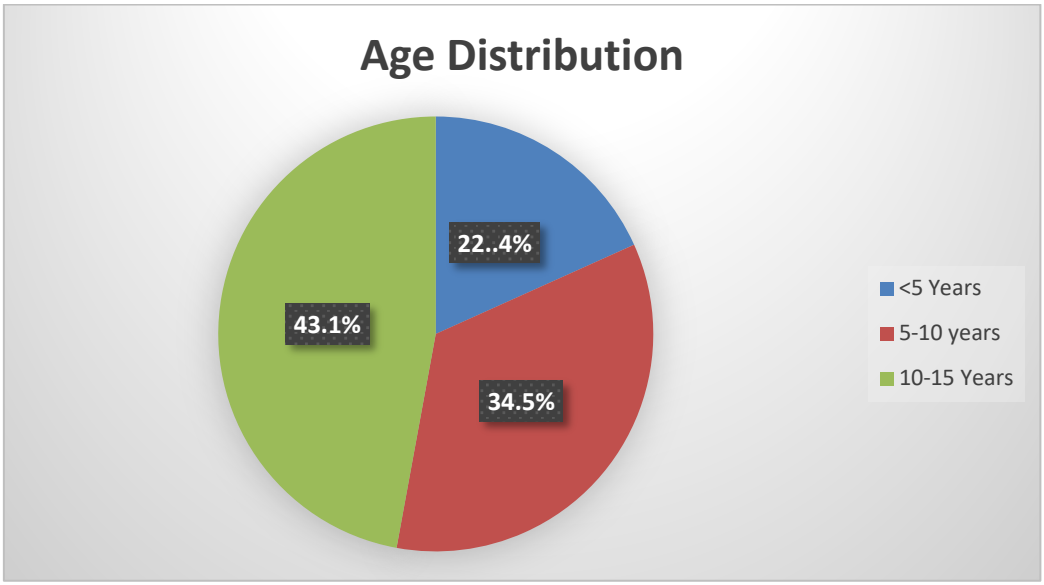

Figure 2: Age distribution of study subjects

46 children (79.3%) were males and 12 (20.7%) were females. 24 cases (41.4%) had RE involvement and 34 cases (58.6%) had involvement of left eye. Injury with household objects while playing was present in 42 eyes (72.4%), accidental falls accounted for 12 cases (20.7%), Road traffic accidents accounted for 3 (5.2%) cases and 1 case(1.7%) reported assault.

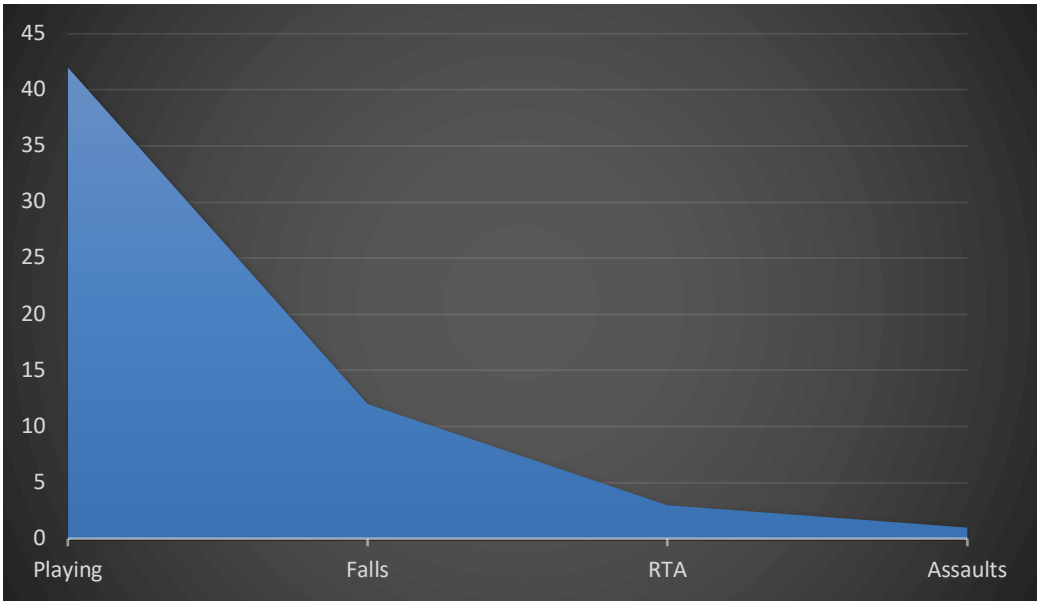

Figure 3: Mode of injury of study subjects

Injury with metallic objects was seen in 24(41.4%) cases, organic matter injury was seen in 19(32.7%) cases, stone in 9(15.5%) cases, plastic in 5 cases (8.6%) and glass in one case [1.7%].

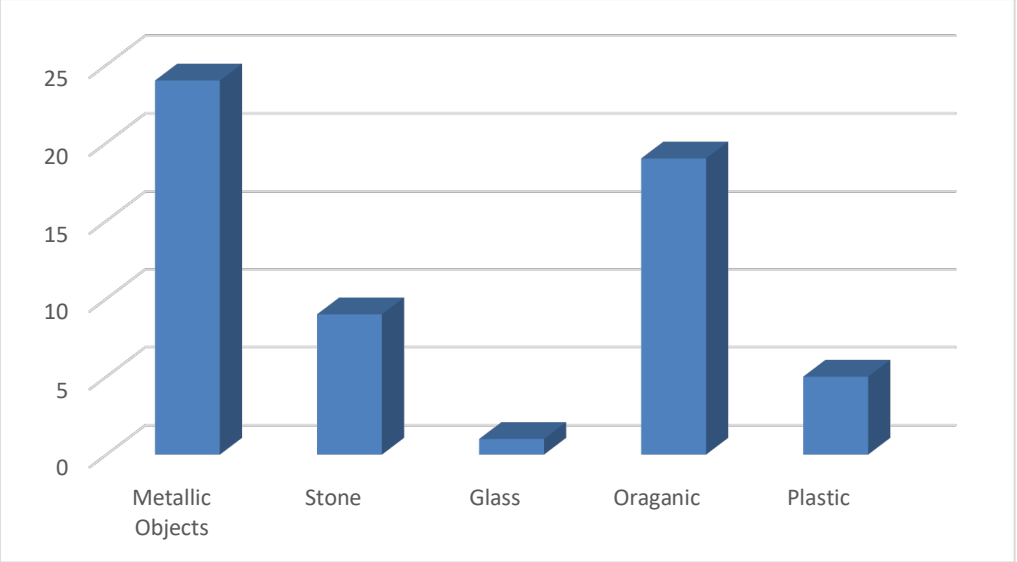

Figure 4: Objects causing injury

Penetrating injury was found to be the most common mechanism of injury found in 54(93.1%) cases.4 cases (6.9%) had globe rupture as mechanism and IOFB was found in 2 cases[3.4%]. There were no cases of perforating injury in our study.

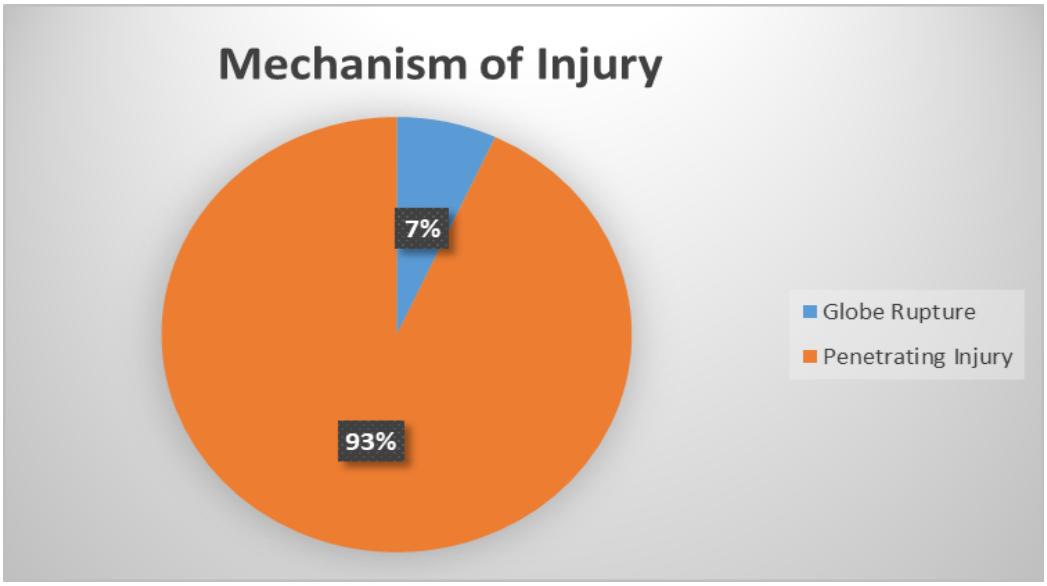

Figure 5: Mechanism of Injury

Majority of our patients i.e. 35 children (60.3%) presented within 6 hours of injury. Only 3 cases (5.2%) presented after 24 hours and hence delay in surgery was present in those three patients. A good Initial visual acuity >20/200 seen in 17 (34.7%) patients and poor visual acuity ie <20/200 was present in 32 (65.3%) cases. In 9 children (15.5%) we were not able to assess Initial visual acuity.

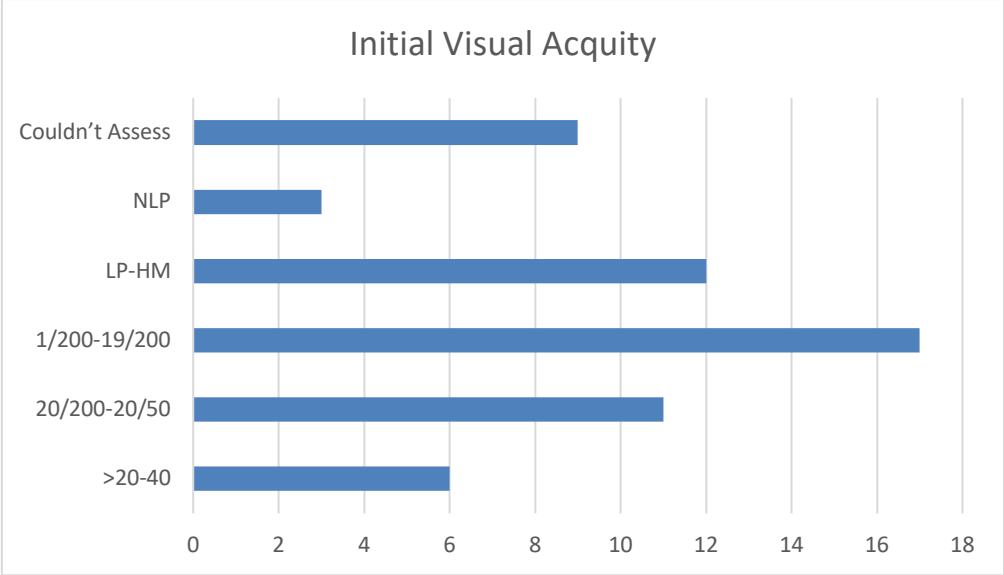

Figure 6: Initial visual acuity of study subjects

Final visual acuity >20/200 was achieved in 35 eyes [60.3%] of which 23 eyes (39.7%) were able to obtain a visual acuity >20/40. Despite optimal surgical management, 23 eyes (39.7%) could only achieve a final visual acuity <20/200 at 6 month follow up. [Table 1]

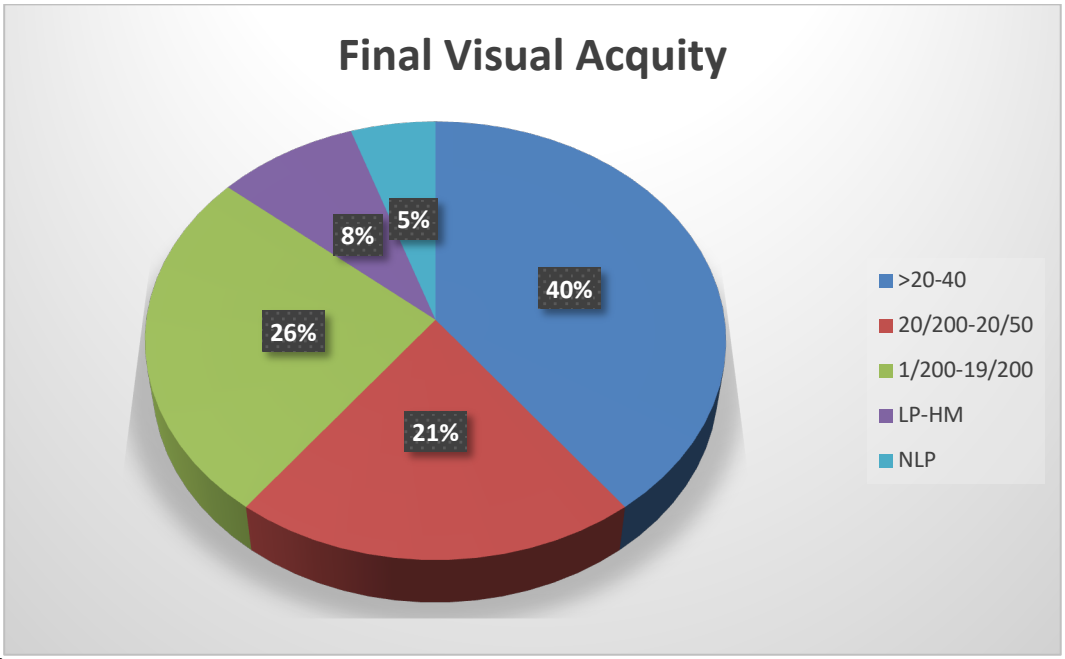

Figure 7: Final Visual Acuity of study subjects

Table 1: Distribution of study population based on Visual Acuity

Visual Acuity	Initial	Final
Good (>20/200)	17 (34.7%)	35 (60.3%)
Poor (<20/200)	32 (65.3%)	23 (39.7%)
Total	49 (100%)	58 (100%)

Majority of our patients had injury in Zone 1(cornea) ie in 40(69%) patients. Zone 2 injuries (limbus to 5 mm posteriorly) were seen in 14 (24.1%) eyes and Zone 3 injuries (posterior wound extent >5mm from limbus)were seen in 4 eyes (6.9%).

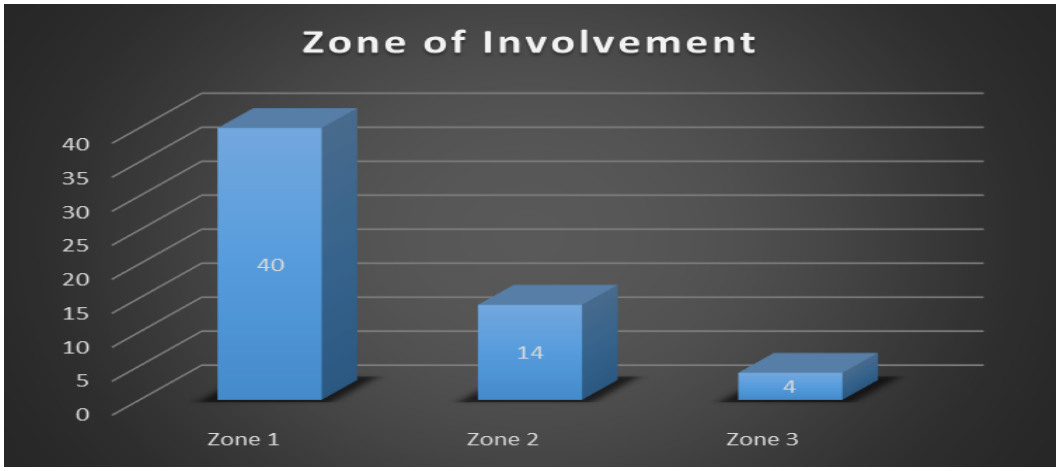

Figure 8: Zone of involvement

In our study, 21 eyes (36.2%) had <5mm wound length, 28 eyes (48.2%) had wound length between 5 -10 mm and 9 eyes (15.5%) had wound length >10mm.

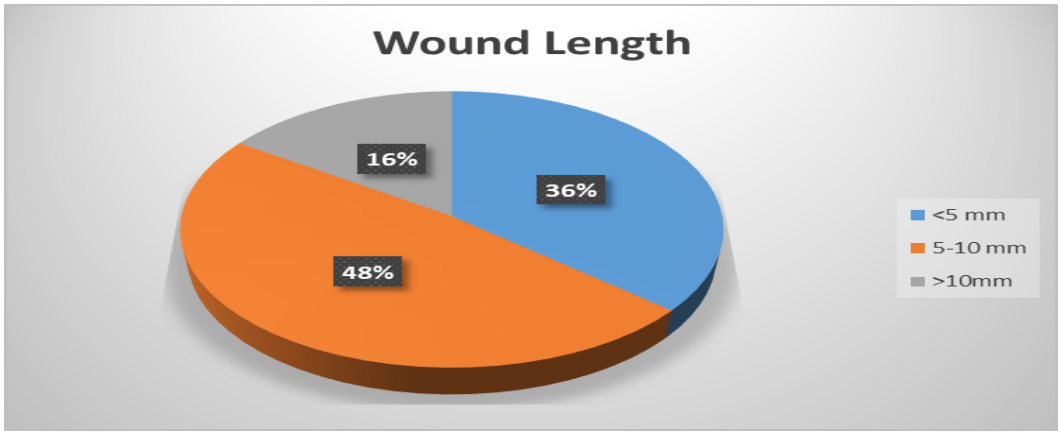

Figure 9: Wound length of injured eyes

Regarding the clinical presentation, iris prolapse was observed in 31 patients (53.4%), hyphema in 17 patients(29.3%), vitreous haemorrhage in 9 patients (15.5%), retinal detachment 4 patients (6.9%) and RAPD in 2 patients(3.4%). Endophthalmitis was seen 8(13.8%) of our patients. Among those who developed endophthamitis, 6 had injury with organic matter, 1 had retained IOFB and 1 patient had delay in surgery >48 hours.

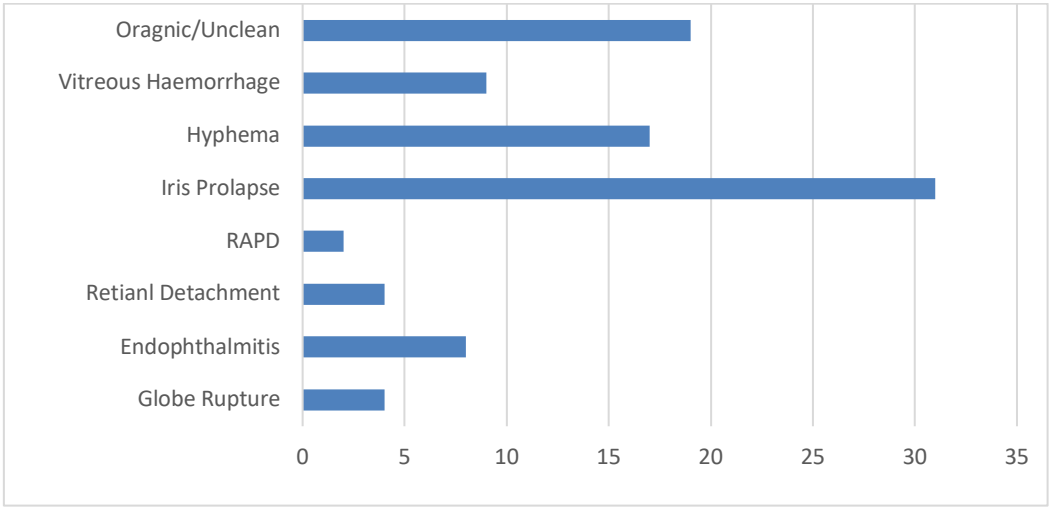

Figure 10: Clinical characteristics of study subjects

At 6-month follow-up, Central Corneal opacity was observed in 30 eyes (51.7%), peripheral corneal opacity in 26 eyes (44.8%) and no opacity in 2 patients at 6 months of follow up. We analyzed the various factors contributing to poor final visual acuity by appropriate statistical methods. Variables like age, gender, side of involvement, cause and type of injury, mechanism of injury and time of presentation to ophthalmic facility did not have a statistical association with final visual outcome.

Among the other prognostic factors studied, initial visual acuity [p<0.001], wound location [p=0.021] and wound length [p=0.001], traumatic cataract [p<0.001], retinal detachment [p=0.021], endophthalmitis [p=0.005], posterior segment involvement [p=0.005] and presence of globe rupture[p=0.021] were found to be statistically significant in determining the final visual outcome[p < 0.05].

Other factors like presence of organic /unclean wounds, delay in surgery, anterior segment involvement, iris prolapse, hyphema, vitreous haemorrhage and RAPD were not found to have statistical significance in contributing to a poor visual outcome in our study subjects [Table 2].

Table 2: Distribution of variables and final visual outcome (level of significance p value <0.05)

Variable		Final Visual outcome		p value
		Poor VA<20/200 (n=23)	Good VA>20/200 (n=35)	
Initial Visual Acuity (n=49)	VA <20/200	19 (59.4%)	13 (40.6%)	<0.001
	VA>20/200	1 (5.9%)	16 (94.1%)	
Globe rupture	Present	4 (100.0%)	0 (0%)	0.021
	Absent	19 (35.2%)	35 (64.8%)	
Endophthalmitis	Present	7 (87.5%)	1 (12.5%)	0.005
	Absent	16 (32.0%)	34 (68.0%)	
Retinal Detachment	Present	4 (100.0%)	0 (0%)	0.021
	Absent	19 (35.2%)	35 (64.8%)	
RAPD	Present	2 (100%)	0 (0%)	0.153
	Absent	21 (37.5%)	35 (62.5%)	
Location	Zone 3	4 (100.0%)	0 (0%)	0.021
	Zone 1/2	19 (35.2%)	35 (64.8%)	
Iris Prolapse	Present	12 (38.7%)	19 (61.3%)	0.875
	Absent	11 (40.7%)	16 (59.3%)	
Hyphema	Present	8 (47.1%)	9 (52.9%)	0.458
	Absent	15 (36.6%)	26 (63.4%)	
Vitreous Haemorrhage	Present	5 (55.6%)	4 (44.4%)	0.460
	Absent	18 (36.7%)	31 (63.3%)	
Organic / Unclean wound	Yes	8 (42.1%)	11 (57.9%)	0.790
	No	15 (38.5%)	24 (61.5%)	
Delay in Surgery	Yes	2 (66.7%)	1 (33.3%)	0.556
	No	21 (38.2%)	34 (61.8%)	
Traumatic Cataract	Present	13 (86.7%)	2 (13.3%)	<0.001
	Absent	10 (23.3%)	33 (76.7%)	
Anterior segment Involvement	Present	19 (47.5%)	21 (52.5%)	0.087
	Absent	4 (22.2%)	14 (77.8%)	
Posterior segment Involvement	Present	11 (68.8%)	5 (31.2%)	0.005
	Absent	12 (28.6%)	30 (71.4%)	
Wound Length	1-5 mm	2 (9.5%)	19 (90.5%)	0.001
	5-10 mm	14 (50.0%)	14 (50.0%)	
	10-15 mm	7 (77.8%)	2 (22.2%)	
Corneal Opacity	No opacity	0 (0%)	2 (100%)	0.001
	Central	19 (63.3%)	11 (36.7%)	
	Peripheral	4 (15.4%)	22 (84.6%)	

Those factors which were found to have a statistically significant association with final visual outcome (p<0.05) in univariate analysis were further analyzed using binary logistic regression using enter method. The logistic regression model was statistically significant, $\chi 2 = 55.901$, $p < 0.001$. The model explained 83.7% (Nagelkerke R2) of the variance in final visual outcome and correctly classified 91.4% of cases. According to this model, factors like having wound length > 10 mm

{AOR=32.128 (p=0.024)}, presence of traumatic cataract {AOR=43.413 (p=0.008)}, endophthalmitis {AOR=131.192 (p=0.031)} and central corneal opacity {AOR=14.395(p=0.049)} were the independent predictors of final visual outcome in the study population. We also attempted to analyze the various causative factors for endophthalmitis in our study population. Endophthalmitis was seen in 8 of our patients among whom 6 had injury with organic material and it was found to be statistically significant (p value= 0.012). Among the 3 cases where delay in surgery beyond 24 hours was present, only 1 developed endophthalmitis [p=0.365]. IOFB was present in 2 patients in our study, one of whom developed endophthalmitis [p=0.259]. [Table 3].All of the children was treated with intravitreal antibiotics and one underwent vitrectomy.

Table 3: Distribution of study population based on endophthalmitis status and selected factors (level of significance p value <0.05)

Variable		Endophthalmitis		P value
		Present (n=8)	Absent (n=50)	
Organic / Unclean wound	Yes	6 (31.6%)	13 (68.4%)	0.012
	No	2 (5.1%)	37 (94.9%)	
Delay in Surgery	Yes	1 (33.3%)	2 (66.7%)	0.365
	No	7 (12.7%)	48 (87.3%)	
Intra Ocular Foreign Body	Present	1 (50.0%)	1 (50.0%)	0.259
	Absent	7 (12.5%)	49 (87.5%)	

Discussion

In this study we have attempted to study the various factors contributing to poor visual outcome in children with open globe injuries. In our study, open globe injury was seen more in males [79.3%] and most of them were under 10 years of age [53%]. This is similar to other studies by Sakrisiriwuto et al., Bunting et al and Toko et al. [3,8,9] Male children were more susceptible to injuries probably due to higher activity level among male children. We also found that injury with household objects while playing was present in 72.4% of which majority was sharp objects like scissors and knives. This corresponds to similar studies by Madhusudhan AP et al and Liu X et al [5,6]. 1.7% of our children suffered assault which has also been previously reported by Lesniak SP et al.[5]

Penetrating injury was found to be the most common mechanism of injury in 93.1% cases and 6.9% had globe rupture. IOFB was found in 2 cases. A similar trend has been reported by many other investigators worldwide [3,5,9,10,11,12]. No cases of perforating injury were noted. On analysis only the presence of globe rupture was found to be an independent risk factor for poor visual outcome in our study[p=0.02].

Majority of our patients had injury in Zone 1 [69%]. Zone 2 injuries were seen in 24.1% and Zone 3 in 6.9% of patients. Other studies also report Zone 1 to be most common site of injury.[3,9,10,11,12]. Zone 3 injuries [posterior wound extent >5mm from limbus] had a worse final visual outcome in our setting[p=0.02]. A wound length more than 10mm also was found to be an independent determinant of poor visual outcome in our study [p=0.001].[6,8,13,14] Initial visual acuity >20/200 seen in 34.7% [n=17] patients and poor initial visual acuity <20/200 was present in 65.3%[n=32] patients. In 15.5% [n=9] we were not able to assess initial visual acuity. Final visual acuity >20/200 was achieved in 60.3% [n=35] and poor final visual acuity <20/200 was seen in 39.7% [n=23]. In a study by Saksiriwuto et al [3], 70% of the patients with penetrating injury had a final visual acuity better than 6/60. On univariate analysis, it was seen that initial visual acuity was a significant predictor of final visual outcome, corresponding too many other similar studies.[6,9,15,16]

The clinical features observed in our patients with open globe injury were iris prolapse [53,4%], hyphema [29.3%], RAPD [3.4%], traumatic cataract [25.9%], vitreous haemorrhage [15.5%], Retinal detachment [6.9%], Endophthalmitis [13.8%] and central corneal opacity [51.7%].

Traumatic cataract was observed in 25.9% [n=15] of our patients of whom 13 children underwent cataract surgery. Traumatic cataract was found to be a statistically significant contributor of poor final visual acuity in our study [p<0.001]. This corresponds to a similar study by C.Xue et al[17]. A study by Saksiriwutto et al [3] observed that 46% of their study subjects had traumatic cataract but no statistical significance was obtained in determining final visual outcome.

It was observed that 6.9%[n=4] of our patients had retinal detachment and all of them had poor visual outcome which was statistically significant (p 0.021)Several previous studies revealed similar results[3,8,9,12,15]. This may point to some possible inadequacies in management of pediatric retinal detachment both in terms of expertise and availability of infrastructure. Though vitreous

haemorrhage was seen in 15.5% it was not found to be statistically significant. Posterior segment involvement [RD, VH, RAPD, Zone3 involvement and endophthalmitis] when considered together was found to significantly affect the final visual outcome [p=0.005]. Though RAPD is a very significant clinical finding, its importance in pediatric open globe injuries cannot be over emphasized. We were able to document RAPD in only 2 of our study subjects and both of them had poor final visual acuity but did not amount to statistical significance[p=0.153]. This may be due to the difficulty in accurately identifying RAPD in the initial period among children with trauma and thereby resulting in an inadequate sample.

Endophthalmitis was seen in 13.8% of our subjects. This is in accordance with a study by Sul et al [15] who reported an incidence of 12.1% of endophthalmitis in pediatric open globe injuries. The presence of endophthalmitis was found to be to be a significant independent predictor of poor final visual acuity on multivariate analysis(p=0.005). This was correlating with the findings of various previous researchers [9,11,12]. We also attempted to study the various factors predisposing to endophthalmitis in these patients and found that injury with organic matter and contaminated wounds were most likely to develop endophthalmitis[p=0.012] [16]. Delay in surgery[>24 hrs], intraocular foreign body, Zone 3 injuries and wound length were the other factors considered but did not obtain any statistical significance probably due to the small sample size[11,19,20].

It was observed that central corneal opacity was present in 51.7% [n=30] of children at 6 month follow-up. It was found to be an independent determinant of final visual acuity on multivariate analysis [p=0.001]. This has been reported in other studies also [21,22]. This emphasizes the importance of timely interventions in preventing amblyopia in pediatric penetrating injuries.

Conclusion

In our study we found that penetrating injury is the most common type of open globe injury in children less than 15 years of age. Male children less than 10 years of age were most susceptible and household injuries while playing was the commonest cause of trauma. The presence of factors like wound length > 10 mm, traumatic cataract, endophthalmitis and central corneal opacity were the independent predictors of final visual outcome in our study population. Despite these factors, with timely intervention and appropriate treatment it was seen that about 60% of our study subjects were able to achieve a final visual acuity >20/200. This stresses the importance of public and parental awareness regarding eye trauma and seeking early medical care. The need for proper follow up and visual rehabilitation is mandatory to prevent amblyopia and permanent visual disability among these children.

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