Original Article

Epidemiology, clinical profile and factors, predicting final visual outcome of pediatric ocular trauma in a tertiary eye care center of Central India

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Purpose: Ocular trauma constitutes an important cause of preventable visual morbidity worldwide. This study was done to study the incidence, sociodemographic pattern, and clinical profile of ocular trauma in pediatric age group. Also to evaluate the factors influencing final visual outcome in these patients. **Methods:** This was a prospective interventional study concerning ocular trauma in pediatric patients up to 16 years of age of either sex. Various variables having an impact on final visual outcome were studied, and results were analyzed using statistical indices – relative risk, Chi-square test, *P* value, and linear regression analysis. **Results:** A total of 220 cases of trauma were evaluated with the mean age being 8.74 ± 3.93 years, males were predominantly affected and open globe injuries outnumbered blunt injuries. Penetrating injuries accounted for 67.79% cases of open globe injury, rupture being the least (2.54%). Stepwise multiple linear regression analysis executed, showed the best predictors in the descending order for final visual outcome were presenting visual acuity, size of corneal tear, type of injury, zone of injury, time period between injury and treatment with a variance of 35.9%, 6.3%, 5.3%, 3.7%, and 2.7%, respectively. All above variables were also found to be statistically significant ($P < 0.05$) on Chi-square test. **Conclusion:** We report the first study on the epidemiology and clinical outcomes of pediatric ocular trauma in central India. Poor initial Visual Acuity and posterior segment involvement adversely affect the visual outcome. Early medical treatment and globe-salvaging repair should be done in all eyes suffering from trauma.

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Ocular trauma can be a devastating injury, causing disability for a lifetime in children. Ocular trauma is an important cause of morbidity and acquired unilateral blindness in this age group.[1,2] Pediatric eye injuries account for approximately 8%–14% of total injuries in children.[3] Such patients have different patterns of ocular injuries than adults and hence require different management protocols. Children below 3 years age group mostly suffer from handler-related injuries such as fingernails of parents, caretakers, or siblings.[4] While older children have injuries due to sharp objects, toys, tree branches, pencils, sports, and stones.[3] Most common emergencies are due to open-globe injuries and require immediate interventions.[5,6] Patient and social education regarding eye injuries and its early specialized treatment can give good visual prognosis.[6] Delayed presentation results in substantial damage to the ocular structures and poor visual outcome in these children.

There is an absence of representative data on the magnitude of ocular trauma in pediatric population, especially in central India. This study provides new insights into the prevalence, risk factors and causes of ocular trauma and morbidity across pediatric age group and is the first report of pediatric ocular injuries in Central India – to analyze the epidemiology, clinical features, visual outcome, and visual prognosis of pediatric ocular injuries presenting to a tertiary care centre in central India.

Methods

The present study was a prospective hospital-based interventional clinical study of 1 year duration from January 15 to January 16 concerning ocular trauma in pediatric age groups. All pediatric patients with age group up to 16 years of either sex having a history of ocular trauma attending casualty or outpatient department (OPD) were included in the study. All enrolled patients were categorized into low, middle, and high socioeconomic status. Patients with various low-income category cards provided by the government like "below poverty line," "Deen dayal card" and no cards were identified as low socioeconomic, middle, and high socioeconomic categories, respectively.

The study was conducted after approval from Institutional Ethics Committee and adheres to the tenets of Declaration of Helsinki. Data were collected after written informed consent from parents. Patient's demographic details such as age, sex, date and time of injury, time lapse between injury and hospital

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attendance, mode of injury, and object causing injury were noted.

Visual acuity in preverbal children was evaluated with tests of - fixation and following/central steady maintenance/preferential looking test - Cardiff Acuity cards. In rest of the children, visual acuity was taken in Snellen's fractions. For purpose of statistical correlation and in accordance to statistical software the final visual acuity was taken in logMAR units. Slit lamp aided anterior segment examination, fundus examination, and intraocular pressure measurement in all eyes except open-globe injuries. B-scan, X-ray, and computed tomography scan were done whenever necessary. Ocular trauma score (OTS) was assigned to all patients. Patients were followed up on day 1, day 7, 1st month, and at 6th month. Final best-corrected visual acuity (BCVA) was evaluated after 6 months.

Statistical analyses were performed using Statistical Package for the Social Sciences software (Version SPSS 22.0/ IBM,Chicago,USA). Data were analyzed with appropriate statistical indices: mean, mode, standard deviation, relative risk, Chi-square test, *P* value, and linear regression analyses. Descriptive statistics on patient demographics and clinical features are reported. Univariate and multivariate logistic regression analyses were performed to identify factors related to profound visual loss, which was defined as visual acuity worse than 0.8 LogMAR. *P* values of 0.05 or less within 95% CI was considered to be statistically significant. A pilot study was done to assess the feasibility of the study, to assess the prevalence of ocular trauma among children and to aid calculate the sample size. A pilot study was conducted among 100 children reporting to eye department (OPD and inpatient department). The prevalence of ocular trauma was found to be 15% among children.

Study sample

The sample size (n) was determined using the following formula:

$$n = \frac{Z^2 \times p \times q}{d^2}$$

Z = Standardized normal deviate (Z value), p = Proportion or Prevalence of interest/(15%).

q = 1 − p/(100 − 15 = 85), d = clinically expected variation (5%).

Allowable error taken was 5%. Keeping 95% confidence interval, 80% power of the study and 15% prevalence of ocular trauma, the sample size was determined to be 220.

$$N = \frac{1.96^2 \times 15 \times 85}{5^2}$$

$N = 196$

With the probability of 10% dropout rate, sample size was increased by 10%, i.e., 216. This was rounded off to 220.

Results

Sociodemographic and clinical profile of pediatric ocular trauma have been described in Table 1. Mean age of presentation was 8.74 ± 3.93 years. School-aged children were more susceptible than the younger age group. Maximum incidence of ocular injuries was found to be 47.27% in 6–10-year age group.

Table 1: Sociodemographic and clinical profile

Age groups (years)	Gender		Number of cases (%)	χ^2:*P*:CI (%)
	Male	Female		
0-5	39	20	59 (26.81)	1.65:0.437:95.00
6-10	69	35	104 (47.27)	
11-16	43	14	57 (25.90)	
Total (%)	151 (68.63)	69 (31.36)	220 (100.0)	
Mean±SD	8.74±3.93			

	Number of cases (%)
Area wise distribution	
Rural	132 (60.00)
Urban	88 (40.00)
Socioeconomic status	
Lower	112 (50.90)
Middle	69 (31.36)
Upper	39 (17.72)
Objects causing injury	
Organic (stick, wheat twig, gullidanda)	65 (29.54)
Metallic (knife, scissor, wire, pen)	31 (14.09)
Stone	24 (10.90)
Alkali	19 (8.63)
Glass	18 (8.18)
Fingernail, fist	15 (6.81)
Others	48 (21.81)
Type of injury open globe	
Rupture	3 (2.54)
Laceration (full thickness)	
Penetrating	80 (67.79)
Perforating	24 (10.90)
IOFB	11 (5.00)
Total	118 (53.63)
Closed globe	
Contusion	43 (59.72)
Laceration (partial thickness)	22 (30.55)
Superficial FB	7 (9.72)
Total	72 (32.72)
Zone of injury in open globe cases	
I	76 (64.40)
II	39 (33.05)
III	3 (2.54)
Zone of injury in closed globe cases	
I	32 (44.44)
II	24 (33.33)
III	16 (22.22)

IOFB: Intraocular foreign body, SD: Standard deviation

Higher prevalence of ocular trauma was seen in males, they being at 2.18 times higher risk as compared to females.

Children from rural areas had 1.5 times higher risk of ocular injuries than urban. Rural:urban ratio being 1.5:1. With reference to socioeconomic status, higher prevalence was seen in lower socioeconomic group (50.90%). Involvement of the left eye was 1.42 times more than the right eye, ratio being 1:1.42.

Wooden object was the most common cause of the injury which accounted 29.54% of all cases. Injury from metallic objects were more common in urban population seen in 61.3% cases.

Penetrating injuries formed the main bulk, accounted for 67.79% cases of open globe injury, rupture being the least (2.54%). As most of injuries in our study were caused by hard and sharp objects such as wooden objects (wooden sticks, *gully danda*, etc.,) metallic objects(knife, scissors, etc.,) stones and glass pieces which tend to cause penetrating injuries, open globe injuries outnumbered blunt injuries. In both open and closed globe injuries cornea being the most exposed part hence Zone I being commonly involved. For purpose of statistical correlation and in accordance to statistical software the final visual acuity was taken in logMar units and categorized into two groups <0.8 logMAR and >0.8 logMAR. Table 2 shows indicative of various factors affecting the final visual outcome type of injury; zone of injury; presenting visual acuity (PVA);

Table 2: Factors affecting visual outcome

Factors	Number of cases, *n* (%)	BCVA		χ^2:*P*:CI (%)
		0-0.8 LogMAR, *n* (%)	1 LogMAR-PL No PL, *n* (%)	
Type of injury				
Open globe				
Rupture	3 (2.54)	0	3 (100.0)	9.11:0.028:95.00
Penetrating	80 (67.79)	30 (37.50)	40 (50.00)	
Perforating	24 (10.90)	2 (8.33)	16 (66.66)	
Retained IOFB	11 (5.00)	2 (18.18)	8 (72.72)	
Closed globe				
Contusion	43 (59.72)	35 (81.39)	8 (18.60)	2.01:0.365:95.00
Laceration (partial thickness)	22 (30.55)	17 (77.27)	2 (9.09)	
Superficial FB	7 (9.72)	7 (100.0)	0	
Zone of injury				
I	108 (56.84)	55 (50.92)	35 (32.40)	5.63:0.060:95.00
II	63 (33.15)	26 (41.16)	35 (55.55)	
III	19 (10.00)	12 (63.15)	7 (36.84)	
Presenting visual acuity				
0-0.8 LogMAR	63 (28.63)	61 (96.82)	2 (3.17)	67.0:0.001:95.00
1 LogMAR-PL, no PL	124 (56.36)	41 (33.06)	81 (65.3)	
Time period between injury and treatment				
Up to 12 h	66 (30.00)	39 (59.09)	22 (33.33)	3.64:0.05:95.00
>12 h	154 (70.00)	66 (42.85)	68 (44.15)	
Size of tear				
<5 mm	88 (40.00)	37 (42.04)	38 (43.18)	14.7:0.001:95.00
>5 mm	22 (10.00)	0	18 (81.81)	
Anterior segment involvement				
Hyphema	59 (26.81)	13 (22.03)	42 (71.18)	25.4:0.001:95.00
Uveal tissue prolapse	78 (35.45)	18 (23.07)	46 (58.97)	
Lens damage	33 (15.00)	22 (66.66)	7 (21.21)	
Posterior segment involvement				
Vitreous hemorrhage	28 (12.72)	3 (10.71)	25 (89.28)	1.84:0.399:95.00
Retinal/choroidal detachment	12 (05.45)	0	12 (100.0)	
Endophthalmitis	4 (1.81)	0	4 (100.0)	
Ocular trauma score (*n*=168)				
1	6 (3.57)	0	6 (100.0)	67.5:0.001:95.00
2	24 (14.28)	2 (08.33)	22 (91.66)	
3	81 (48.21)	35 (43.20)	44 (54.32)	
4	18 (10.71)	14 (77.77)	4 (22.22)	
5	39 (23.21)	39 (100.0)	0	

IOFB: Intraocular foreign body, PL: Perception of light, LogMAR: Logarithm of the minimum angle of resolution, CI: Confidence interval, BCVA: Best corrected visual acuity time period between injury and treatment; size of tear; anterior segment involvement; posterior segment involvement; and OTS. With reference to type of wound 37.50% and 81.39% patients with penetrating injuries and contusion wounds respectively could achieve final visual acuity <8 logMar units. In 28.63% patients presenting with visual acuity better than 0.8 LogMAR, 96.82% achieved final visual acuity better than 0.8 logMAR as opposed to 56.36% who presented with visual acuity worse than 0.8 logMAR, in which meager 33.06% cases achieved final visual acuity better than 0.8 logMAR. Various factors affecting final visual outcome are summarized in Fig. 1. Graph depicts the difference in the height of two lines, line 1 indicates poor outcome and line 2 indicates good outcome. There is a considerable difference in height of two lines at each point with respect to various variables indicating how an independent variable affects the final visual outcome.

Discussion

To the best of our knowledge, this study is the first of its kind to reflect the magnitude of ocular trauma in a large sample of central Indian population and adequately puts down the incidence; sociodemographic pattern and visual outcome of pediatric ocular trauma in central India which has previously not been reported. A Medline search was initiated with PubMed and Medline plus for a combination of cluster of keywords – prevalence, incidence, epidemiology, pediatric, children, eye, ocular, trauma, injury, Birmingham Eye Trauma Terminology system, OTS open globe, close globe, rupture, laceration, penetrating, perforating, incidence, and outcome. One keyword/phrase from each cluster was used, unless repeated. All reports consisting of ≥25 patients published between January 1997 and April 2017 were evaluated.

The incidence of pediatric ocular trauma was found to be 12.8% in this study. Dandona and Dandona[7] reported that ocular trauma accounts for 4.2%–7% of all childhood blindness though the total incidence was not reported. Shukla.[8] in 1994 reported the incidence of ocular trauma as 57 cases/10,000/year, though this incidence was for all age groups and denominator being all ocular cases coming to hospital.

The knowledge about epidemiological and sociodemographic aspects, causative factors, and visual outcome assumes special significance in trauma-related blindness of a child because a child suffers from more blind years than a blind adult.

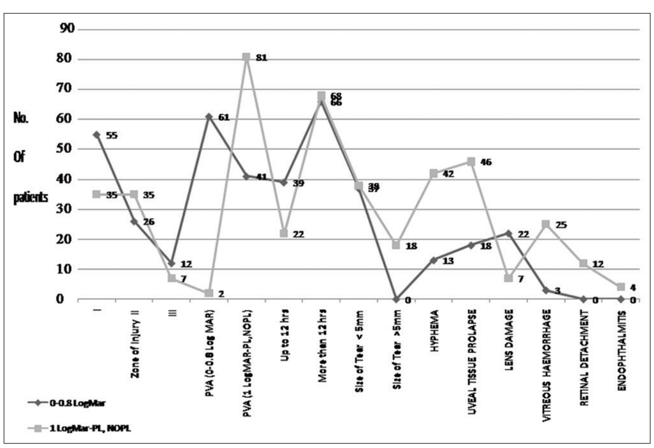

Figure 1: Factors affecting visual outcome

Estimates of the number of children blind in India because of trauma and their causes are relatively less as there are little reported epidemiologic data. Thus, there is a lack of organized approach to the control of childhood blindness in many parts of the country. The availability of accurate estimates of data pertaining to prevalence and incidence rates of pediatric ocular trauma can go a long way in controlling pediatric childhood blindness. Thus this study was undertaken to ascertain the estimates of incidence rates and outcome of pediatric ocular trauma.

Higher incidence amongst males can be explained on the basis, that boys are granted more freedom than girls and tend to spend more time outside with less adult supervision and exhibit more uninhibited behavior as compared to females. Furthermore, in Indian society, more importance with regards to treatment is given to boys in the event of any illness or trauma as compared to girls. It is more likely that ocular trauma to girls remains unattended and untreated, reflecting as a higher prevalence of reported cases in males.

Injuries by wooden stick and vegetative matter are relatively common in our scenario as wooden objects are readily available in the form of play objects - gully danda, pencil, wooden sticks, etc. A study done by Saxena *et al*.[9] revealed bow and arrow to be the commonest object of injury seen in 15.2% cases, which showed a decline in present study to just 2.1% cases.

Penetrating injuries being the most common type of injury, necessitates adequate preventive measures in the form of counseling of parents, caretakers and children and awareness drives especially in school, with special emphasis on adequate precautions, preventive measures, and immediate ophthalmic consultation in the event of an injury. In addition, it may be worthwhile to educate the parents, caretakers and school staff about important symptoms of ocular injuries for the justifiable reason that children may at times fail to report their injuries to guardians leading to complications of delayed intervention.

Study did not show trauma incidence to have predilection for any particular season and received a constant inflow of patients of pediatric ocular trauma throughout the year, whereas some studies[10] did report a seasonal variation in inflow of pediatric patients. PVA serves as an important predictor of final visual outcome in direct association. On linear regression analysis, it was found to be statistically significant for predicting final vision outcome with $P = 0.001$, regression equation final visual outcome = −0.0459 + 0.4553 PVA. As opposed to study by Agrawal *et al*.[11] who reported that initial visual acuity can be a cause of poor visual outcome in cases with the concurrence of endophthalmitis. Although our findings suggest that PVA is a reflection of the extent of damage caused due to trauma with reference to size of corneal tear, uveal tissue involvement, traumatic cataracts, and posterior segment involvement.

Early intervention stands more chances of better visual outcome, whereas in cases of delayed presentation there are more chances of substantial damage, inflammation, and secondary infection with squeal which may deteriorate the condition and less likely to have good outcome. Studies[12,13] reported that final visual acuity was significantly poor in eyes where the primary repair was delayed beyond 24 h.

Size of wound bore an inverse relationship to visual outcome. In corneal tears ≤5 mm, 42.04% achieved final visual acuity of ≤0.8 logMAR or better. As the size of corneal tear or laceration increases there are more chances of prolapse of intraocular contents and injury to vital structures, more inflammation and increased risk of secondary infection. Furthermore, during the postoperative period, tear size ≤5 mm resulted in astigmatism <2 D as compared to tears ≥5 mm which resulted in irregular astigmatism of >2D [Table 3]. Studies[14,15] have reported visual outcome to be poor in cases of large-sized wounds, though they did not report its correlation with postoperative astigmatism. Also tears in pupillary area involving the visual axis lead to a poor prognosis. Patients with zone 1 injury were categorized into three groups with reference to location of tear whether involving papillary axis or not [Table 4]. It was substantiated that tears which were peripheral to pupillary axis had better visual outcome as compared to central tears involving the visual axis.

Anterior segment involvement in the form of hyphema, uveal tissue prolapse may further worsen the prognosis. Just 22.03% cases achieved final visual acuity ≤0.8 logMAR if hyphema was present at the time of presentation. In addition, posterior segment involvement at the time of presentation was poor prognostic factor. None of the patients with retinal detachment, choroidal hemorrhage/detachment, vitreous loss, Retained intraocular foreign body achieved final visual acuity of ≤0.8 logMAR. Meager 10.71% cases of vitreous hemorrhage achieved BCVA of ≤0.8 logMAR. Posterior segment injuries are more visually devastating than anterior segment injury or ocular adnexal injury. These injuries, despite adequate and timely treatment when available, continue to leave children with permanent vision impairment after resolution. Various studies[16-18] reported poor visual outcome in cases with posterior segment involvement.

OTS[19] serves as a prognostic model to predict the visual outcome of patients after ocular trauma. It is calculated by assigning numerical raw points to six variables: initial visual acuity, globe rupture, endophthalmitis, perforating injury, retinal detachment, and relative afferent pupillary defect. Scores are subsequently stratified into five categories from one to five with one being the lowest score and five being the highest. Patients with OTS of one will have a higher risk of poorer final visual outcome as against the patient with OTS score of five. About 96.2% of patients with OTS 5 could achieve vision ≤0.8 logMar as opposed to just 6.2% of patients with OTS 1

Table 5 shows indicative of final visual outcome in direct relationship to type of injury, PVA, time period between injury and treatment, size of tear, anterior segment involvement, and OTS. Stepwise multiple linear regression analysis which was executed to estimate the linear relationship between the final visual outcome as a dependent variable and various independent variables. It shows that the best predictors in the descending order for final visual outcome were PVA, size of corneal tear, type of injury, zone of injury, time period between injury and treatment with a variance of 35.9%, 6.3%, and 5.3%, 3.7%, and 2.7%, respectively. It also reveals that all the independent variables were significantly associated with final visual outcome.

Conclusion

The current burden of ocular trauma in pediatric age group presenting to a tertiary care hospital in central India has been quantified from this study, and a quantified estimate of the incidence of subsequent visual outcome has been provided. This study reports maximum incidence of pediatric ocular trauma in school going children with sharp organic objects as the most common cause of injury. The proportion of injuries resulting from bow and arrow was low against injuries due to sharp metallic and wooden objects which are becoming more prevalent and carry a risk of poor visual outcome. The profound visual loss was associated with delayed intervention especially in cases with poor vision at presentation and involvement of the posterior segment.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Table 3: Length of corneal tear in relation to postoperative astigmatism

Length of corneal tear	*n* (%)	Astigmatism		χ^2:df:*P*:CI (%)
		Upto 2 days, *n* (%)	>2 days, *n* (%)	
Up to 5 mm	88 (81.48)	59 (67.04)	12 (13.63)	29.2:1:0.001:95.00
>5 mm	20 (18.51)	4 (20.0)	16 (80.0)	

CI: Confidence interval, dF: Degree of freedom

Table 4: Site of corneal tear in relation to visual outcome

Corneal tear	*n* (%)	BCVA		χ^2:df:*P*:CI
		0-0.8 LogMAR, *n* (%)	1 LogMAR-PL No PL, *n* (%)	
Central	35 (32.40)	6 (17.14)	23 (65.71)	22.4:2:0.001:95.00
Peripheral	57 (52.77)	32 (56.14)	15 (26.31)	
Both	16 (14.81)	2 (12.5)	12 (75.0)	

CI: Confidence intervel, PL: Perception of light, dF: Degree of freedom, BCVA: Best corrected visual acuity, LogMAR: Logarithm of the minimum angle of resolution

Table 5: Stepwise multiple linear regression analysis with final visual outcome as a dependent variable

Model	*R*	R^2	ANOVA *F*	*P*
1	0.599[a]	0.359	107.516	0.001[a]
2	0.649[b]	0.422	69.679	0.001[b]
3	0.689[c]	0.475	57.224	0.001[c]
4	0.715[d]	0.512	49.547	0.001[d]
5	0.547[e]	0.539	41.96	0.001[e]

[a]Predictors: Constant, presenting visual acuity, [b]Predictors: Constant, presenting visual acuity, size of corneal tear, [c]Predictors: Constant, presenting visual acuity, size of corneal tear, type of injury, [d]Predictors: Constant, presenting visual acuity, size of corneal tear, type of injury, zone of injury, [e]Predictors: Constant, presenting visual acuity, size of corneal tear, type of injury, zone of injury, time period between injury and treatment

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