

# A prospective cohort study on the epidemiology of ocular trauma associated with closed-globe injuries in pediatric age group

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**Purpose:** To study the epidemiology of mechanical ocular trauma and closed globe injury using the Birmingham Eye Trauma Terminology System in patients belonging to the pediatric age group. **Methods:** This work involved a prospective cohort study of all ocular trauma patients (pediatric age group) registered between 2002 and 2017 at the ocular trauma care center. The data were collected using the international ocular trauma society form through our online MIS data and exported to the Excel sheet. The statistical analyses including the univariate analysis and cross tabulation were carried out using SPSS 22 software. **Results:** Our cohort consisted of 12687 patients with mechanical ocular trauma. There were 7546 (59.4%) eyes with open globe ocular injuries and 5328 (41.9%) with closed globe injuries. Of all closed globe injury patients, 1010 (19.0%) belonged to the pediatric age group (0-18 years), including 690 males (68.3%) and 320 females (31.7%). The mean age of the patients was  $10.2 \pm 5.1$  years. Of all closed globe injuries, 692 (68.5%) were closed globe contusion and 318 (31.5%) were lamellar laceration. **Conclusion:** Closed globe injury is an important in cause of vision loss in children (24% <1/60). The condition is more prevalent in males and >51.7% in children under 10 years of age. The treatment has significant impact on the visual outcome in patients belonging to the pediatric age group.

**Key words:** Birmingham eye trauma terminology system, blunt ocular trauma, pediatric ocular trauma

Trauma is a major cause of monocular blindness in the developed countries. Although the etiology of ocular injury in rural places is likely to differ from that in the urban areas, only a few studies have specifically addressed the problem in rural areas.<sup>[1]</sup> Therefore more studies are required to overcome this major issue in rural areas.<sup>[2-4]</sup> Any preventive strategy requires a knowledge about the cause of injury, which may enable more appropriate targeting of the resources for avoiding them. Both the victims of eye trauma and the society at large bear a huge burden, which is potentially preventable.<sup>[3]</sup> Children affected by eye trauma exert more economic burden to the society as they have more blind years to live. Eye trauma patients belonging to the pediatric age group face specific challenges in regard to rehabilitation as well as amblyopia in particular.<sup>[4-6]</sup>

With the introduction of the Birmingham Eye Trauma Terminology System (BETTS),<sup>[7]</sup> the documentation of ocular trauma has now been standardized.<sup>[5]</sup> Closed globe injury is considered to be less frequent and less severe.<sup>[8,9]</sup> The present study was designed to investigate the exact incidence, situations that causes mechanical eye injuries in similar settings. The study findings will help us preventing the vision loss in children.

Our study was conducted in a city located in the border of the three Indian states: Gujarat, Madhya Pradesh, and Rajasthan. Qualified ophthalmologists of our institute provide low-cost eye services primarily to the poor people belonging to the tribal population of 5.3 million residing in the area.

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## Methods

We obtained the approval from the hospital administrators and research committee to conduct this study. We also obtained the written consents from all participants. Approval date 1 January 2016

This research was a prospective study designed in 2002. Children with ocular injury in either of the eye who presented, diagnosed and managed between January 2003 and December 2017 were enrolled in the study. Patients who consented to participate and not presented with any other serious body injury were included. We divided all participants in closed globe injuries according to the BETTS and studied them.

For each patient enrolled in the study, we obtained a comprehensive history, including the details of injury and information on the treatment and surgery performed to manage the past ocular trauma. The data were collected from both initial and follow-up reports using the online BETTS format of the International Society of Ocular Trauma. The details of the surgery were also gathered using a specified pre-tested online form.

The closed globe group was subdivided into lamellar laceration and contusion.

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Other demographic details included residence, activity at the time of injury, object causing the injury, and previous examinations and treatments. After their enrollment, all patients were tested using a standardized method. Visual acuity was checked using the JAAPOS guidelines and the anterior segment was examined using a slit lamp or hand held slit lamp. Ocular and adnexal tissues affected were documented.

For a partially opaque lens, the posterior segment examination was carried out with an indirect ophthalmoscope and a +20 D lens. When the optical medium was not clear, a B-scan was performed to evaluate the posterior segment. Children not allowing the examination were investigated under anesthesia.

In children younger than 2 years, both lensectomy and vitrectomy via a pars plana route were performed, and the same surgical procedures were used to manage the traumatic cataract. The lens implantation as a part of the primary procedure was avoided in children younger than 2 years.

The patients with injuries without infection were treated with the topical and systemic corticosteroids and cycloplegics. The duration of medical treatment depended on the degree of inflammation in the anterior and posterior segments of the eye. The post-treatment patients were re-examined consecutively after 24 h, 3 days, and 1, 2, and 6 weeks to enable refractive correction. Post which the re-examination was done monthly for 3 months, and then every 3 months for 1 year.

At every follow-up examination, visual acuity was tested with the JAAPOS guidelines. The anterior and posterior segments were examined using a slit lamp and an indirect ophthalmoscope, respectively.

During examination, the data entry was carried out online using a specified pretested format designed by the International Society of Ocular Trauma (initial and follow-up forms) and later exported to Microsoft Excel spreadsheets. The data were audited periodically to ensure completion.

We used the Statistical Package for Social Studies (SPSS 22) to analyze the data. The univariate parametric method was employed to calculate the frequency, percentage, proportion, and 95% confidence interval (95% CI). We applied binominal regression analysis to determine the predictors of post-treatment satisfactory vision (>20/60). The dependent variable was vision >20/60 noted at the follow-up. The independent variables were age, gender, residence, time interval between the injury and surgery, primary posterior capsulectomy and vitrectomy procedures and type of ocular injury.

## Results

Our cohort consisted of 12,687 patients with mechanical ocular trauma. There were 7546 (59.4%) eyes with open globe ocular injuries and 5328 (41.9%) with closed globe injuries. Of all closed globe injury patients, 1010 (19.0%) belonged to the pediatric age group (0-18 years), including 690 males (68.3%) and 320 females (31.7%) [Table 1]. The mean age of patients was 10.2 ± 5.1 years. Of all closed globe injuries, 692 (68.5%) were closed globe contusion and 318 (31.5%) were lamellar laceration.

Of the 5328 blunt trauma patients, we identified 1010 (19.0%) who belonged to the pediatric age group. In addition, 22.6% of patients were under 5 years of age.

Play was the most common activity among kids <5 years (628, 62.2%) that caused injuries at home or in other places. In

contrast, domestic (122, 12.1%) and professional (48, 4.63%) activities were the most frequent causative factors among teens and other children [Fig. 1].

Wooden object and stone were the most common causative factors for the injury, which were observed in 498 (49.3%) and 166 (16.4%) cases, respectively [Fig. 2].

Conjunctiva was the most commonly affected tissue in closed globe injury, which was found in 521 eyes (51.1%), followed by the cornea (497, 49%) [Fig. 3].

Comparative studies between the pre- and post-treatment data yielded a significant difference in the visual outcome (Table 2, *P* = 0.000). Comparative study of the visual outcome between the subcategories of closed globe injury showed a significant difference [Table 3]. Moreover, comparative study between the children of different age groups who possibly have amblyopia reflected a significant difference (Table 4, *P* = 0.000). Of all cases, only 68 (6.7%) required surgical treatment.

In terms of outcome, 649 eyes (64.3%) regained >6/24 visual acuity, whereas 247 eyes (24.5%) did not regain more than 1/60. We found the involvement of 1 – 6 tissues in all cases. [Table 5] In addition, we found a significant difference in visual outcome with respect to the number of tissues involved (*P* = 000).

## Discussion

Our cohort consisted of 12687 patients with mechanical ocular trauma. There were 7546 eyes (59.4%) with open globe ocular injuries and 5328 (41.9%) with closed globe injuries classified by BETTS.

We could not find any study that has specifically reported only closed globe injuries in patients belonging to the pediatric age group; the majority of the studies have reported overall eye injuries in children.<sup>[10-17]</sup>

Majority studies reported smaller case series or retrospective studies as far as blunt trauma is concerned.<sup>[10-17]</sup> Very few studies had a cross-sectional design.<sup>[18]</sup>

Some researchers have reported prospective studies, but these are not specific for closed globe injuries and classified according to BETTS.<sup>[19-25]</sup>

The current study reported that the mean age of patients was 10.2 years. The current study reported a significant difference in the visual outcome between below and above 5 years which is in accordance with the report by shah *et al.*<sup>[26]</sup>

In the present study, the percentage of male patients was 68.3. Similarly, Serrano has reported 64.9% of male patients<sup>[10]</sup> and Sharifzadeh has reported a male to female ratio of 2.3:1.<sup>[19]</sup>

Other prospective studies have involved overall trauma rather than specifically including the blunt trauma. Only Canavan *et al.* have conducted a prospective study with blunt

**Table 1: Age and sex distribution**

Age category	Sex		Total
	F	M	
0-2	30	48	78
3-5	63	87	150
6-10	83	201	284
11-18	144	354	498
Total	320	690	1010

trauma cases; but, the study has not included only the pediatric age group.<sup>[26]</sup>

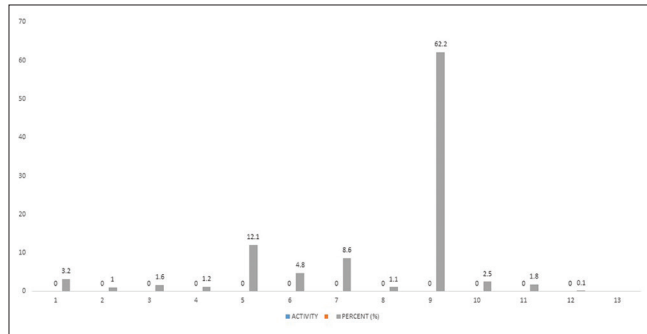


Figure 1: Activities during blunt ocular trauma

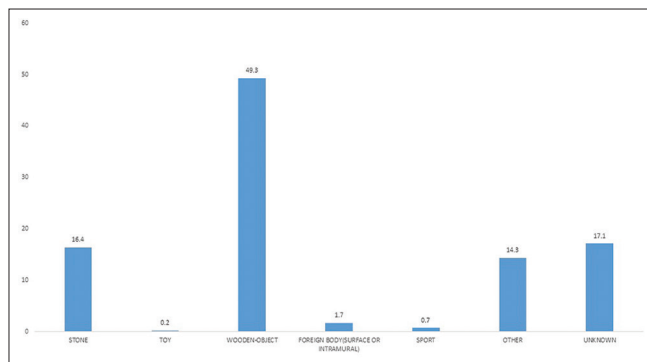


Figure 2: Objects causing blunt ocular trauma

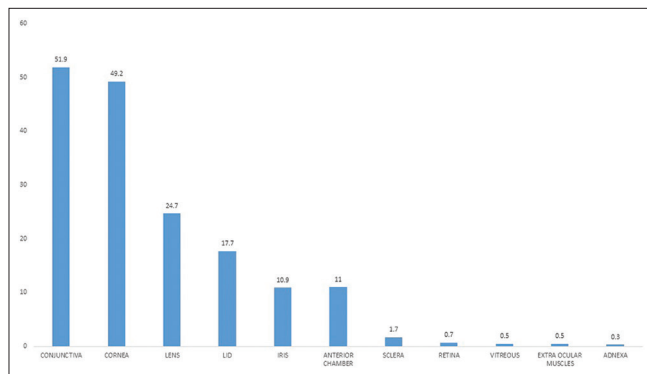


Figure 3: Tissue affected during blunt ocular trauma

Serrano has reported 35% of blunt trauma and Liu has reported 71% of open globe injuries.<sup>[10]</sup> This contradiction may be because of the classifications according to the BETTS.

Khokhar *et al.* have reported that the incidence of open globe injury is three fold higher than the closed globe injury; however, the current study reported that the incidences of closed globe and open globe injuries are 41.9% and 59.4%, respectively.<sup>[8]</sup>

Shah *et al.* have reported that the visual outcome is better in closed globe injury patients belonging to the pediatric age group. However, we observed a visual regain of >6/24 in 64.2% of cases.<sup>[9]</sup>

The current study reported that 64.3% of eyes regained >6/24 visual acuity, whereas 28% did not regain beyond 1/60. Serrano has reported that most of the closed globe injuries do not cause severe visual loss.<sup>[27]</sup> This may be because of the less severe injuries. Onyekonwu has reported a final visual outcome of >6/18 in 35.1% of cases; but, this is not specific for closed globe injuries.<sup>[12]</sup>

Majority of the studies have reported that home is the most common location and play is the most common activity related to injuries<sup>[8-10,22]</sup>

The percentage of surgeries was 6.7 in closed globe injuries according to the BETTS. We did not find any study reporting this.

Rohr *et al.* have reported that the cornea is affected in 54% of eyes in respect to all types of injuries, whereas the current study reported that the cornea is affected in 49% of eyes – only in respect to cases of closed globe injuries.<sup>[18]</sup> We did not find any study that has reported the number of tissues involved, as well as the comparative differences in visual outcome.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

**Conclusion**

Closed injuries (according to BETTS) in pediatric population can cause severe sight loss in 24% cases (<1/60). Closed globe contusion is more common than lamellar laceration.

**Table 2: Comparative study of visual outcome pre and post treatment following closed globe injury in pediatric age group**

Post treatment vision	Pre treatment vision						Total	
	<1/60	1/60-5/60	6/60-6/36	6/24-6/18	6/12-6/9	6/6-6/5		UNCOOP
<1/60	229	0	4	4	5	5	0	247
1/60-5/60	11	8	15	5	4	2	2	47
6/60-6/36	11	5	26	2	2	0	1	47
6/24-6/18	19	4	10	176	11	6	5	231
6/12-6/9	17	4	9	13	110	45	2	200
6/6-6/5	16	1	4	11	28	156	2	218
UNCOOP	0	0	0	5	0	0	15	20
TOTAL	303	22	68	216	160	214	27	1010

P=0.000

**Table 3: Comparative study of visual outcome with sub groups of closed globe injury in pediatric age group**

Post treatment vision	Closed globe		Total
	Contusion	Lamellar laceration	
<1/60	205	42	247
1/60-5/60	32	15	47
6/60-6/36	33	14	47
6/24-6/18	138	93	231
6/12-6/9	123	77	200
6/6-6/5	146	72	218
UNCOOP	15	5	20
TOTAL	692	318	1010

P=0.000

**Table 4: Comparative study of visual outcome pre and post treatment following closed globe injury in pediatric age group according to age category**

Post treatment vision	Age category		Total
	<5	>5	
<1/60	21	226	247
1/60-5/60	1	46	47
6/60-6/36	10	37	47
6/24-6/18	157	74	231
6/12-6/9	17	183	200
6/6-6/5	6	212	218
UNCOOP	16	4	20
TOTAL	228	782	1010

P=0.000

**Table 5: Number of tissue involved**

Number of tissue affected	Percentage of cases
1	41.1
2	49.1
3	6.5
4	2.3
5	0.7
6	0.3
Total	

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**Conflicts of interest**

There are no conflicts of interest.

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