



Open globe injuries in children under 7 years referred to a tertiary center in Iran from 2006 to 2016.

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Abstract

Purpose: Open globe injuries are one of the most common causes of monocular blindness in many countries. The impact of this traumatic event on patients' quality of life and health is considerable. This study describes the characteristics of open globe injury in children younger than 7 years.

Methods: Six hundred and twenty-two patients were included in this retrospective study. Patients under 7 years with open globe injury were included.

Results: Among 622 patients, 403 (64.8%) were male and 219 (35.2%) were female. The type of material that caused the open globe injury was metallic material in 355 (57.1%) cases, wood in 89 (14.3%) cases, glass in 87 (14%) cases, plastic in 30 (4.8%) cases and other materials in 61 (9.8%) cases. The time between the occurrence of ocular trauma to patient admission was <12 hours in 414 (66.6%) patients and between 12 and 24 hours in 101 (16.2%) patients. The time between patient admission to first surgical intervention was <12 hours in 493 (79.3%) patients, between 12 and 24 hours in 88 (14.1%) patients. The rate of traumatic endophthalmitis in our study was 14.3% at presentation. The most common organism was *Streptococcus viridans*. Traumatic endophthalmitis was significantly related to the male gender, the time between the occurrence of ocular trauma to patient admission, and time between patient admission to first surgical intervention and wooden material ($p < 0.001$).

Conclusion: This study showed that open globe injuries were more prevalent in boys older than four years. The earlier patient's referral was associated with a lower rate of endophthalmitis. The most common cause of traumatic endophthalmitis in pre-school children was *S. viridans*.

Introduction

Ocular trauma is one of the most important health problems in children, which can cause blindness and other ocular complications [1]. Thirty-five percent of all traumatic retinal injuries in the United States are found in children younger than 17 years [2]. Ocular trauma in children is one of the important causes of unilateral visual loss and acquired blindness [3]. Ocular trauma is the most common cause of preventable enucleation or evisceration in children younger than 3 years. Children with ocular trauma are exposed to an

increased risk of amblyopia [4, 5]. Ocular trauma and vision loss in pediatrics are more important owing to long-term social and psychological impacts [3, 6]. Vision loss owing to ocular trauma in children can be prevented by simple measures such as the supervision of parents or caregivers [7].

The most commonplace of ocular trauma in children is home but in some developing countries, outdoor injuries are more prevalent [6–9]. Ocular trauma occurs more frequently in boys than in girls in both developing and developed countries [1, 2, 4, 5]. Most of the ocular trauma in children occurs in spring and summer during physical activity and some studies showed that the most common cause of referral is traumatic hyphema [1, 2, 4, 5, 7, 10].

Although ocular trauma is the most common cause of monocular blindness in developing countries and Iran, there are few studies in these countries and none of these studies specifically performed on children under 7 years [3, 6–9, 11–13]. Owing to the importance of ocular trauma

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in children and lack of recent evidence in this field, we design this study to evaluate the characteristics of open globe injuries in children younger than 7 years.

Materials and methods

This study was a retrospective study in 622 children younger than 7 years with open globe injuries that were referred to Farabi Eye Hospital (Tehran, Iran) between January 2006 and January 2016. Open globe injury was defined as any full-thickness traumatic wound of the globe. Patient data obtained from the medical archive and incomplete patient documents were excluded. Of 1226 pediatric patients, 604 were excluded because of incomplete data records. Medical records were examined to determine the age, sex, place, instrument that caused the injury, type of the open globe injury, zone of the open globe injury, presence or absence of traumatic endophthalmitis, the time between occurrence of the trauma to admission, the time between admission to first surgical intervention, type of the first surgical intervention, and visual acuity at the time of discharge. Wound location was defined according to the Ocular Trauma Classification as zone I if the injury was confined to the cornea and limbus, Zone II injuries indicated the anterior 5 mm of the sclera (not extending into the retina), and Zone III injuries involved full-thickness scleral defects more posterior than 5 mm from the limbus. Penetrating injury defined as full-thickness laceration from a sharp object with only one entry site to the globe. Perforating injury defined as full-thickness globe laceration from a sharp object that passes through the globe with separate entry and exit sites. Globe rupture defined as any form of open globe injury due to blunt trauma. Traumatic endophthalmitis defined clinically based on the presence of vitritis. Traumatic endophthalmitis at presentation was defined as clinically diagnosed endophthalmitis any time between first examination at emergency department to pre-operative examination just before first surgical intervention.

The study was performed in accordance with the declaration of Helsinki and was approved by the institutional ethics committee at Farabi Eye Hospital.

Statistical methods

Data analysis was performed using SPSS version 25. All the percentages were reported without considering the missing data. T-test and Mann–Whitney *U* tests were used to compare means. For evaluating the association between two categorical variables, we used the Chi-Square test, two-tailed Fisher exact test. We considered *p* values <0.05 to be statistically significant.

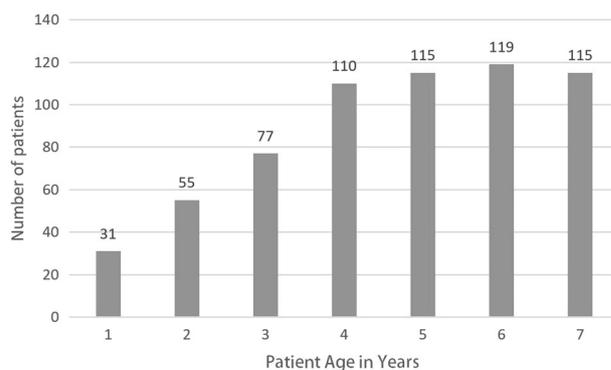


Fig. 1 Patients' age. Age distribution of children with open globe injuries.

Results

Of the 622 patients included in this study, 31 (5%) patients were one or <1 year old, 55 (8.8%) between 1 and 2 years old, 77 (12.4%) between 2 and 3 years old, 110 (17.7%) between 3 and 4 years old, 115 (18.5%) between 4 and 5 years old, 119 (19.1%) between 5 and 6 years old and 115 (18.5%) between 6 and 7 years old (Fig. 1). The average age of our patients was 4.75 years with a standard deviation of 1.75 years. Our study showed that most open globe injuries occurred in children older than 4 years (459 patients, 74%; $p < 0.001$) and fewest occurred at the age of 1 year old. In all, 403 (64.8%) patients were male and 219 (35.2%) patients were female. The right eye was involved in 344 (55.3%) cases and left eye in 278 (44.7%) cases.

Type of open globe injury was penetrating injury in 590 (94.9%) patients, intraocular foreign body (IOFB) in 28 (4.5%) patients, perforating injury in 2 (0.3%) patients and globe rupture in 2 (0.3%) patients. In 68% of cases, the injury was limited to zone 1 followed by injuries involving both zone 1 and zone 2 in 19.3% of cases.

The type of material that caused open globe injury was metal in 355 (57.1%) patients, wood in 89 (14.3%) patients, glass in 87 (14%) patients, plastic in 30 (4.3%) patients, and other materials in 61 (9.8%) patients (Fig. 2).

The time between the occurrence of the ocular trauma to patient admission was <12 hours in 414 (66.6%) patients, between 12 and 24 hours in 101 (16.2%) patients and >24 hours in 107 (17.2%) patients. The time between the patient admission to first surgical intervention was <12 hours in 493 (79.3%) patients, between 12 and 24 hours in 88 (14.1%) patients and >24 hours in 41 (6.6%) patients. (All underwent surgical procedure).

The first surgical intervention was primary repair alone in 321 (51.6%) patients, primary repair with lensectomy and/or anterior vitrectomy in 145 (23.3%) patients and primary repair with deep vitrectomy (with or without lensectomy) in 156 (25.1%) patients.

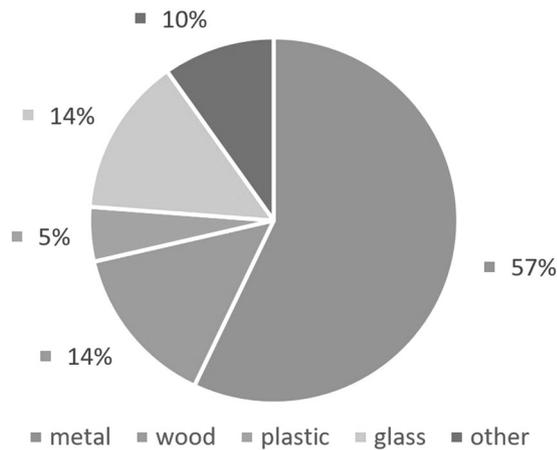


Fig. 2 Material Types. Type of the material that caused open globe injury.

The rate of traumatic endophthalmitis in our study was 14.3% at presentation. Among 89 patients presented with signs of traumatic endophthalmitis; anterior chamber or vitreous samples had positive cultures in 23 (25.8%) cases and 63 (74.2%) had negative cultures. The most frequent microorganism cultured from the anterior chamber was *Streptococcus viridans* in 33% of samples followed by *Staphylococcus epidermis* and *Haemophilus* each in 22% of cases. The most frequent microorganism cultured from vitreous was *S. viridans* in 37% of samples followed by *Haemophilus* in 16% of samples.

This study showed that traumatic endophthalmitis was significantly related to patient sex, the time between the occurrence of the ocular trauma to patient admission and the time between the patient admission to first surgical intervention. IOFB was not a risk factor for traumatic endophthalmitis (p value = 0.06). Table 1 shows the relationship between traumatic endophthalmitis and sex, type of open globe injury, the time between the occurrence of ocular trauma to patient admission, the time between patient admission to first surgical intervention, type of first surgical intervention, and type of material that caused open globe injury.

Visual acuity at the time of discharge was obtained in 499 patients (123 patients were not cooperative for visual acuity measurement); among these patients, visual acuity was $>20/200$ in 356 (71.3%) and $<20/200$ in 143 (28.7%) patients. Male sex, time to admission, time to surgery >24 hours, and wooden material were significantly related to traumatic endophthalmitis.

Discussion

Our study showed that open globe injury is more prevalent in males than females (68.5% and 31.5%, respectively), this

finding is also in accordance with the study that was performed by Cao et al. [5] in Chaoshan region of China in 2013 that showed male to female ratio in ocular trauma was 3.3:1. In the study performed by Armstrong et al. [10] in the United States in 2013, 61.5% of patients were male. The more aggressive nature of playing among boys compared with girls would place them at higher risk of ocular trauma. These findings also emphasize the importance of more supervision of boys during playing.

The majority of the traumatic open globe injuries in our study were caused by metallic objects (58%) such as scissors, knives, and screwdriver. The second and third prevalent materials that caused traumatic open globe injury were wood and glass, respectively. These findings were also mentioned in our previous study that documented the knife as the most frequent culprit of pediatric (under age 16) ocular trauma [13]. In the study performed by Lesniak et al. [14] in the United States in 2012, most open globe injuries were related to accidents; this finding was in contrast to our study. To explain this difference, we should note a higher age of patients (up to 19) in the former study. They introduced sharp objects as the second cause of ocular trauma.

The average age of our patients was 4.75 years and open globe injuries were significantly higher in children older than 4 years. In the studies that were performed by Read et al. in the United States in 2016 and Gunes et al. in Turkey in 2015 the mean age of the patients was 4.2 years and 4.38 years, respectively [15, 16]. It emphasizes the need for more educational training support about ocular trauma for children and their parents in this age group.

The prevalence of right-handed people may explain the higher probability of injury in the right eye as these children grasp objects by their dominant hand. This finding is in accordance with the study performed by Gunes et al. that 61.3% of open globe injuries were on the right eye [16].

Our study showed that penetrating ocular injury accounts for 96.3% of cases followed by IOFB in 3.4%. Initial surgical intervention was primary repair without lensectomy and vitrectomy in 48.84%. This finding was also in accordance with the studies performed by Read et al. and Gunes et al. [15, 16]. In our study and other similar studies in children, most of the open globe injuries occurred at home [16, 17]. There is a significant relationship between sex and open globe injury, although metallic objects were the most causative object to result in open globe injury in both sexes, boys using these objects, are more than girls [15–17].

The rate of traumatic endophthalmitis in our study was 14.3% at presentation. The rate of traumatic endophthalmitis in children after open globe injury ranged from 2.8% to 71.8% in different studies [17]. Gram-positive organisms

Table 1 The relationship between traumatic endophthalmitis and sex, type of open globe injury, the time between the occurrence of the ocular trauma to patient admission, the time between patient admission to first surgical intervention, type of first surgical intervention and type of material that caused open globe injury.

Variables	Mean \pm SD	Groups	Endophthalmitis. number (percent)		Statistical significance (p value)
			No	Yes	
Age (years)	4.75 \pm 1.75	<4	163		
		4–7	459		
Sex		Male	71 (82.6%)	332 (61.9%)	$p < 0.001$
		Female	15 (17.4%)	204 (38.1%)	
Diagnosis		Penetrating injury	80 (93%)	510 (95.1%)	$p = 0.21$
		Intraocular foreign body	4 (4.6%)	24 (4.5%)	
		Perforating injury	1 (1.2%)	1 (0.2%)	
		Globe rupture	1 (1.2%)	1 (0.2%)	
Time to admission		Less than 12 h	27 (31.4%)	387 (72.2%)	$p < 0.001$
		Between 12–24 h	20 (23.3%)	81 (15.1%)	
		More than 24 h	39 (45.3%)	68 (12.7%)	
Time to surgery		Less than 12 h	34 (36.5%)	459 (85.6%)	$p < 0.001$
		Between 12 and 24 h	13 (15.1%)	75 (14%)	
		More than 24 h	39 (46.3%)	2 (0.4%)	
Treatment		Primary repair	47 (54.7%)	274 (51.1%)	0.07
		Primary repair with lensectomy and/or anterior vitrectomy	28 (32.6%)	117 (21.8%)	
		Primary repair with deep vitrectomy	11 (12.8%)	145 (27.1%)	
Instrument		Metal	35 (40.7%)	320 (59.7%)	$p < 0.001$
		Wood	36 (41.9%)	53 (9.9%)	
		Plastic	1 (1.2%)	29 (5.4%)	
		Glass	7 (8.1%)	80 (14.9%)	
		Other materials	7 (8.1%)	54 (10%)	

were more prevalent. The most common organism was *S. viridans* in the anterior chamber and vitreous cultures. Similar findings were obtained from studies that were performed by Alfaro et al. in the United States in 1995 and two literature review by Khan et al. in 2014 and Sheng et al. in Chinese literature in 2017 that showed gram-positive organisms were more prevalent in children's traumatic endophthalmitis [18–20]. The causative organism of traumatic endophthalmitis in children is also different from the adults, that most of the cases caused by Streptococcus species [17]. Alfaro et al. found that Streptococcus organisms were more prevalent in children's traumatic endophthalmitis although Sheng et al. found that Staphylococcus epidermidis was more prevalent [18, 20]. Our study found a significant relationship between the time of the patient's referral and traumatic endophthalmitis as emphasized by similar studies [17, 21]. It is important to perform the primary repair for open globe injuries as soon as possible to reduce the rate of traumatic endophthalmitis. Unfortunately, traumatic endophthalmitis could severely affect the visual outcome in these children [22]. In >60% of patients, the

time between the occurrence of the ocular trauma to patient admission and the time between patient admission to first surgical intervention was less than 12 hours. Our study had certain limitations. It was a retrospective study; 49% of patients were excluded because of incomplete documents; also, extended follow-up data from patients were not studied.

In conclusion, open globe surgery was more common in boys older than 4 years old and the commonplace was home. The rate of traumatic endophthalmitis was 14% and the most common cause of traumatic endophthalmitis was *S. viridans* in pre-school children. Earlier patient's referral was associated with a lower rate of traumatic endophthalmitis.

What was known before:

- Open globe injuries are one of the most common causes of monocular blindness in many countries. The impact of this traumatic event on patients' quality of life and health is considerable. This study describes the

characteristics of open globe injury in children younger than 7 years.

What this study adds:

- This study showed that open globe injuries were more prevalent in boys older than 4 years. The earlier patient's referral was associated with a lower rate of endophthalmitis. The most common cause of traumatic endophthalmitis in children younger than 7 years was *S. viridans*.

Compliance with ethical standards

Conflict of interest The authors did not receive any financial support from any public or private sources. The authors have no financial or proprietary interest in a product, method, or material described herein.

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