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ORIGINAL RESEARCH

Characteristics of Hospitalized Pediatric Patients Following Traumatic Open Globe Injuries; a Cross-sectional Study

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Abstract: **Introduction:** One of the main causes of acquired blindness and impairment in children is ocular trauma. This study aimed to evaluate the epidemiological and clinical characteristics of pediatric patients hospitalized with open globe injuries (OGI). **Methods:** A retrospective cross-sectional study was conducted on children diagnosed with OGI at a referral Hospital affiliated with Isfahan University of Medical Sciences, Isfahan, Iran, from 2014 to 2018. **Results:** 375 OGI medical records were detected during the study period. The common culprits for OGI in boys were knives (21.3%), wood (19.7%), metal bodies (12.2%), and glass (11.8%). In girls, the common causes were knives (28.7%), glass (24.3%), pencils (11.3%), and wood (10.4%). Boys had a greater rate of Intraocular foreign body (IOFB) (p= 0.052) but had lower odds of blindness compared to girls (OR=0.48; 95% CI: (0.24, 0.98); p = 0.04). Patients with corneal lacerations had lower chances of long-term admission than those with corneal and scleral lacerations (OR= 0.35, 95% CI: (0.17, 0.69); p = 0.02). **Conclusion:** Most pediatric OGIs occur in boys. knives were the principal culprit for OGI, followed by glass and wood. Boys had a greater IOFB rate but lower blindness odds than girls.

Keywords: Eye Injury, Trauma, Visual Impairment, Blindness, Pediatrics

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1. Introduction

One of the main causes of acquired blindness and impairment in children is ocular trauma (1). These injuries negatively impact the children's behavior and social development over the long run. To decrease the frequency and severity of ocular injuries, it is required to assess the epidemiological features of ocular trauma in children (2). Ocular traumas are divided into open and closed-globe injuries. A full-thickness defect in eyewall following a penetrating trauma with sharp objects, foreign bodies, etc. is defined as open globe injury (OGI). The closed globe injury is categorized as an anterior or posterior segment injury and a superficial foreign body injury (3).

Around the world, 55 million people experience eye damage that limits their activities for more than one day each year (4). According to research conducted in Singapore, 5% of persons have had ocular injuries (5, 6). The ocular trauma epidemiology varies among countries, particularly in developing countries. In the developed world, 5% of all ophthalmic admissions are caused by ocular trauma. Large demographic, social, and cultural differences can be important reasons for this variation (7). In children, eye injuries are not similar to adult ocular trauma in terms of evolution, management instructions, and causes. Ocular trauma in children encompasses a range of injuries from non-penetrating or corneal scratches to penetrative or total corneal and scleral injuries (8). The prevalence and seriousness of vision impairment or blindness brought on by ocular trauma in children range from 2% to 14% globally, according to various studies (9-11). Nearly 35% of all ocular trauma cases in the United States are part of the pediatric population. Open-globe injuries are

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more common in boys than in girls, and the most frequent type of injury is penetration by sharp objects. Also, OGIs occur in children at home more than anywhere else (12). According to some studies conducted in northeast Colombia, Turkey, Kuwait, Hong Kong, and Italy, there has been a higher rate of pediatric ocular trauma in boys and a higher prevalence in non-penetrating groups than in penetrating ones (13). Although some studies in Iran investigated the prevalence of eye injury, information about the severity of ocular trauma in the juvenile population is lacking (14). In this study, pediatric patients hospitalized for OGI in a tertiary referral eye hospital in Isfahan, Iran, during a five-year period were described in terms of their epidemiological and clinical characteristics.

2. Methods

2.1. Study design and setting

This study is a retrospective study of children diagnosed with OGI at a referral Hospital affiliated with Isfahan University of Medical Sciences, Isfahan, Iran, from 2014 to 2018. Using International Classification of Diseases (ICD) codes that contained the phrases ocular trauma, open globe injury, penetrating trauma, perforating trauma, full-thickness laceration, globe rupture, corneal laceration, and scleral laceration, qualified pediatric patients were located by searching the hospital's electronic and non-electronic database sources. The study was conducted under the provisions of the Helsinki Declaration. The study protocol was approved by the Ethics Committee of Isfahan University of Medical Sciences (Approval number: IR.ARI.MUI.REC.1402.214).

2.2. Participants

Inclusion criteria comprised pediatric patients with documented OGI who were admitted for medical care. The age range for inclusion was defined according to pediatric standards, typically 18 years. Cases with unambiguous diagnoses of OGI, as determined by ophthalmic examination and medical records, were included. The study's main outcome aimed to capture a comprehensive overview of the epidemiological and clinical aspects of OGI in this specific population. Exclusion criteria involved patients outside the defined age range, those with incomplete or missing medical records, and cases where the diagnosis of OGI was uncertain or disputed. Additionally, patients were excluded if they had congenital anomalies or medical conditions unrelated to the external trauma.

2.3. Data gathering

Baseline characteristics of patients (gender, age, et al.), residential area (urban vs. rural), the mechanism of injury, duration from trauma to hospital admission, and length of stay in the hospital were collected for all patients from the hospital's electronic and non-electronic database sources, using a predefined checklist. Also, other clinical variables were gathered, including the presence or absence of a laceration site, type of trauma, and endophthalmitis. The mechanism of injury was classified into main groups, including metal (metal body, knife, needle, wire, scissor), wood (wood, pencil), glass, stone, and others (accident, band, bullet, cracker, others). A trained ophthalmology resident was responsible for data gathering.

According to the WHO, individuals in this research who had visual impairment were divided into four categories based on their visual acuity: mild (less than 6/12), moderate (less than 6/18), severe (more than 6/60), and blind (less than 3/60) (15). Depending on the patient's age, we utilized the teller acuity test for preverbal children and the Snellen acuity test for school-aged children at a distance of 20 feet (6 m).

2.4. Statistical analyses

Continuous variables were represented as means (SD) and medians (Q1–Q3 for the interquartile range). Numerals were used to describe categorical variables (percentages). The Kolmogorov-Smirnov test was used to judge the data's normalcy. The independent sample t-test or Mann-Whitney test was used to compare continuous variables between boys and girls. The Chi-Square test was also used to examine categorical variable frequencies between boys and girls. Crude univariate and adjusted multiple logistic regressions were used to assess the relationships between the risk factors of age, gender, intraocular foreign body (IOFB), laceration site, and mechanism of trauma, with endophthalmitis (yes, no), visual acuity (blindness, non-blindness), and time of admission (= three days, and >= four days). Age, gender, location (rural or urban), length of hospital stay, mechanism of injury, location of laceration, and IOFB were all considered in the models. STATA 12.0 was used to perform all statistical analyses (STATA Corp, College Station, Texas, USA). P values less than 0.05 were regarded as statistically significant.

3. Results

The data of 375 patients with a mean age of 8.03 ± 4.74 (range:1-18) years were studied (69.1% boys). Table 1 shows the characteristics of patients by gender. Boys were significantly older than girls (p= 0.006). Furthermore, metal (boys=108 (66.7%), girls=54 (33.3%)), wood (boys=68 (73.1%), girls= 25 (26.9%)) and stone (boys= 47 (58.8%), girls= 33 (41.3%)) were more prominent causes of trauma in boys compared to girls (p= 0.006). Also, the IOFB was marginally significantly higher in boys than girls (p= 0.052). Besides, the rate of blindness in boys was higher than in girls, which was marginally significant (p= 0.054). However, other variables between girls and boys were not significant (p>0.05). The mechanisms of trauma are presented in more detail in Figure 1. Knives were the principal culprit for OGI, followed by glass and wood.

The outcomes of the logistic regression models are shown in Table 2. The risks of becoming blind were lower in boys than in girls (OR=0.48; 95% CI: (0.24, 0.98); p = 0.04). Additionally,

in both the crude model (OR= 0.32, 95%CI: (0.12, 0.85)) and the adjusted model (OR= 0.35; 95%CI: (0.13, 0.99)), patients who were traumatized by a wood object had lower chances of long-term hospitalization (four days) than other mechanisms. In both the crude model (OR= 0.35, 95% CI: (0.17, 0.69)) and the adjusted model (OR= 0.45; 95% CI: (0.22, 0.91)), patients with corneal lacerations had decreased chances for long-term admission. No clear connection between any of the risk variables and endophthalmitis was discovered.

4. Discussion

This study's preliminary results have revealed that most pediatric OGI occurred in boys; knife-sharp objects were the principal culprit for OGI, followed by glass and wood, and boys had a greater rate of IOFB but had lower odds of blindness than girls. Additionally, compared to other mechanisms, individuals whose trauma was caused by a wood item had a lower probability of long-term hospital stay (four days). Patients with corneal lacerations were less likely to require prolonged hospitalization than those who also had scleral lacerations. None of the variables were shown to be significantly linked to endophthalmitis.

In this study, pediatric OGI occurred in boys more than twice as much as in girls, which is in line with other studies (10, 16-19). The male-to-female ratio of injuries was 2.2, consistent with most studies on this topic (18, 20, 21). These findings are due to the violent nature of young boys games and high physical contact with damaging materials. Also, females are highly valued and regarded in our culture and society who are less active and move gently. This figure illustrates that girls have a lower risk of ocular trauma than boys.

We found that the mean age of children with OGI was almost eight years old, and other studies on pediatric eye trauma revealed that their patients were mostly under ten years old (9, 20, 22). In addition, children at this age are active with more freedom to play without supervision.

Our findings indicated that the geographic location of the patients residence had no significant impact on the injuries. As reported by others, a substantial percentage of patients were from urban areas (67.73%) (23, 24). In contrast, some findings were reported by Singh et al. (25) and Katiyar et al. (26), which show a high prevalence of eye injuries in rural populations. The differences between urban and rural populations may be due to high-risk activities; more motor vehicle crashes in urban areas, and improvement in rural eye care facilities, limiting referrals to urban centers.

According to the current study, metal injuries (from knives, needles, metal bodies, wires, and scissors) were the most common cause of OGI (43.2%), which is in line with Nikandish's (27) and Wang et al. (28) studies and in contrast with other studies (25, 26, 29, 30) which reported wooden materials as a common cause of eye injuries. On the one hand, metal materials are often sharp which increases the risk of eye injuries.

On the other hand, these results might be explained by the accessibility of metallic material for children at home.

Our results showed that the IOFB was more common in boys than girls among different types of OGI, which is in line with other studies on this topic (10, 12, 29).

The results didn't find any significant association between mentioned risk factors and endophthalmitis. However, individuals with low age, low visual acuity (VA) upon admission, the presence of the IOFB, and a prolonged hospital stay had a greater chance of developing endophthalmitis in research on post-traumatic endophthalmitis (31).

The results found that cornea laceration has a reverse association with admission time. Injuries affecting the cornea and limbus frequently correlate with a good functional outcome (32).

Another finding of this study was that the likelihood of long-term hospitalization was lower for individuals with wood trauma. Overall, it was demonstrated that favorable VA following open globe injury is predicted by a good initial VA, a shorter wound length, the absence of retinal detachment, and a relative afferent papillary defect (33). So it might be because the wooden materials caused OGI in our study didn't induce considerable injury in depth and length, and by good VA, most of them were discharged early.

5. Limitations

The data in these studies are static, but the epidemiology of OGI is dynamic, which poses a serious constraint to their findings. Although the data were taken from one hospital's records, this study could not accurately measure the number of people at risk, and there was no long-term follow-up. Additionally, since there were no minor trauma cases, there was a tendency to underestimate the true incidence of open-globe injuries. However, the primary conclusions of this study are not significantly impacted by these limitations.

6. Conclusions

This study depicts a view of pediatric ocular trauma caused by OGI. Most childhood eye injuries are preventable. However, in order to reduce the occurrence of ocular trauma, increasing parental supervision and awareness, and improving education emphasizing the prevention of particular hazards are recommended. In addition, understanding the basics of eye damage can aid pediatricians, ophthalmologists, and other professionals involved in the clinical treatment of children in decreasing related visual loss and ocular morbidity.

7. Declarations

7.1. Acknowledgments

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7.2. Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

7.3. Funding

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7.4. Financial Disclosure

None of the authors has any financial disclosures.

7.5. Authors' contribution

Alireza Peyman: Conceptualization, Methodology, Investigation, Formal analysis, Writing – review &editing.
Alireza Dehghani: Methodology, Investigation, Formal analysis, Writing – review & editing.
Alireza Hoghooghi: Investigation, Methodology, Writing – review & editing.
Kazhaal Sheykhi: Investigation, Methodology, Writing – review & editing.
Mehri Khoshhali: Investigation, Methodology, Writing – review & editing.
Mahdi Abounoori: Conceptualization, Methodology, Writing – review & editing.
Hajar Khosrropour: Investigation, Methodology, Writing – review & editing.
Mohsen Pourazizi: Conceptualization, Methodology, Investigation, Formal analysis, Writing – review &editing.
All authors read and approved the final version of the manuscript.

7.6. Availability of data and materials

The data sets generated for this study are available at reasonable request to the corresponding author.

7.7. Using artificial intelligence chatbots

None.

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Table 1: Demography and characteristics of patients by gender

Variables	Total (n=375)	Girls (n=116)	Boys (n=259)	P
Age (years)	8.03 ± 4.74	6.98 ± 4.27	8.49 ± 4.88	0.006
Time to admission (days)	0.54 ± 1.20	0.56 ± 1.31	0.53 ± 1.16	0.75
Time to surgery (days)	0.76 ± 1.27	0.73 ± 1.35	0.77 ± 1.24	0.37
Length of hospital stay (days)	4.19 ± 1.12	4.16 ± 1.16	4.20 ± 1.12	0.83
BCVA (LogMAR)	2.29 ± 1.26	2.46 ± 1.15	2.22 ± 1.29	0.13
Living place				
Urban	254	79 (31.1)	175 (68.9)	0.92
Rural	121	37 (30.6)	84 (69.4)	
Laceration Site				
Cornea	257	78 (30.4)	179 (69.6)	0.25
Sclera	38	16 (42.1)	22 (57.9)	
Corneal and Scleral	80	22 (27.5)	58 (72.5)	
visual impairment (according to WHO)				
Non-Blindness	69	14 (20.3)	55 (79.7)	0.054
Mild or no impairment	20	6 (30)	14 (70)	
Moderate impairment	27	4 (14.8)	23 (85.2)	
Severe impairment	22	4 (18.2)	18 (81.8)	
Blindness	206	67 (32.5)	139 (67.5)	
Mechanism of injury				
Metal	162	54 (33.3)	108 (66.7)	0.006
Wood	93	25 (26.9)	68 (73.1)	
Stone	80	33 (41.3)	47 (58.8)	
Others*	33	3 (9.1)	30 (90.9)	
Hyphemia				
Yes	223	67 (30)	156 (70)	0.64
No	143	47 (32.9)	96 (67.1)	
Iris prolapse				
Yes	194	59 (30.4)	135 (69.6)	0.91
No	149	47 (31.5)	102 (68.5)	
Traumatic cataract				
Yes	68	19 (27.9)	49 (72.1)	0.76
No	212	64 (30.2)	148 (69.8)	
Intra Ocular Foreign Body				
Yes	40 (10.66)	7 (17.5)	33 (82.5)	0.052
No	335 (89.33)	109 (32.5)	226 (67.5)	
Endophthalmitis				
Yes	13 (3.46)	4 (30.8)	9 (69.2)	0.99
No	362 (96.5)	112 (30.9)	250 (69.1)	

Data are presented as mean ± standard deviation or frequency (%). *: Accident, Band, Bullet, Cracker, etc.
BCVA: best-corrected visual acuity, WHO: World Health Organization.

Table 2: Association between risk factors with endophthalmitis, visual acuity, and length of hospital stay

Outcomes	Crude		Adjusted	
	OR (95% CI)	**P-value**	**OR (95% CI)**	**P-value**
Endophthalmitis				
Age	1.07(0.96, 1.19)	0.25	1.09 (0.96, 1.22)	0.18
Sex: Male	1.01(0.30, 3.34)	0.99	0.80 (0.22, 2.84)	0.73
IOFB	2.64(0.69, 10.01)	0.15	2.18 (0.52, 9.19)	0.29
Laceration Site				
Cornea	1.58(0.34, 7.36)	0.56	1.49 (0.31, 7.30)	0.62
Sclera	1.05(0.09, 12)	0.97	1.12 (0.10, 13.18)	0.93
Cornea & Sclera (Ref.)				
Mechanism				
Metal	1.23(0.14, 10.58)	0.85	1.92 (0.20, 18.54)	0.57
Wood	1.82(0.20, 16.16)	0.59	2.56 (0.25, 26.06)	0.43
Glass & Stone	0.41(0.02, 6.67)	0.53	0.52 (0.03, 9.45)	0.66
Others (Ref.)				
Visual acuity				
Age	0.94 (0.88, 1.00)	0.053	0.94 (0.88, 1.01)	0.09
Sex: Male	0.53 (0.27, 1.02)	0.056	0.48 (0.24, 0.98)	0.04
IOFB	0.47(0.23, 0.98)	0.04	0.54 (0.24, 1.19)	0.13
Laceration Site				
Cornea	0.54 (0.26, 1.16)	0.11	0.66 (0.30, 1.47)	0.31
Sclera	0.65 (0.22, 1.95)	0.45	0.80 (0.25, 2.53)	0.70
Cornea & Sclera (Ref.)				
Mechanism				
Metal	1.41(0.53, 3.76)	0.49	0.92 (0.32, 2.63)	0.88
Wood	0.67(0.25, 1.80)	0.42	0.51 (0.17, 1.49)	0.21
Glass & Stone	0.62 (0.23, 1.67)	0.35	0.42 (0.14, 1.22)	0.11
Others (Ref.)				
Length of hospital stay				
Age	0.99 (0.94, 1.03)	0.55	0.97 (0.92, 1.03)	0.29
Sex: Male	1.43 (0.88, 2.31)	0.15	1.43 (0.85, 2.41)	0.18
IOFB	0.65 (0.33, 1.30)	0.23	0.72 (0.34, 1.52)	0.39
Laceration Site				
Cornea	0.35 (0.17, 0.69)	0.003	0.45 (0.22, 0.91)	0.02
Sclera	0.51 (0.19, 1.37)	0.18	0.62 (0.22, 1.70)	0.35
Cornea & Sclera (Ref.)				
Mechanism				
Metal	0.98 (0.37, 2.58)	0.96	0.92 (0.33, 2.57)	0.88
Wood	0.32 (0.12, 0.85)	0.02	0.35 (0.13, 0.99)	0.04
Glass & Stone	0.46 (0.17, 1.26)	0.13	0.51 (0.18, 1.47)	0.21

OR: odds ratio; CI: confidence interval.

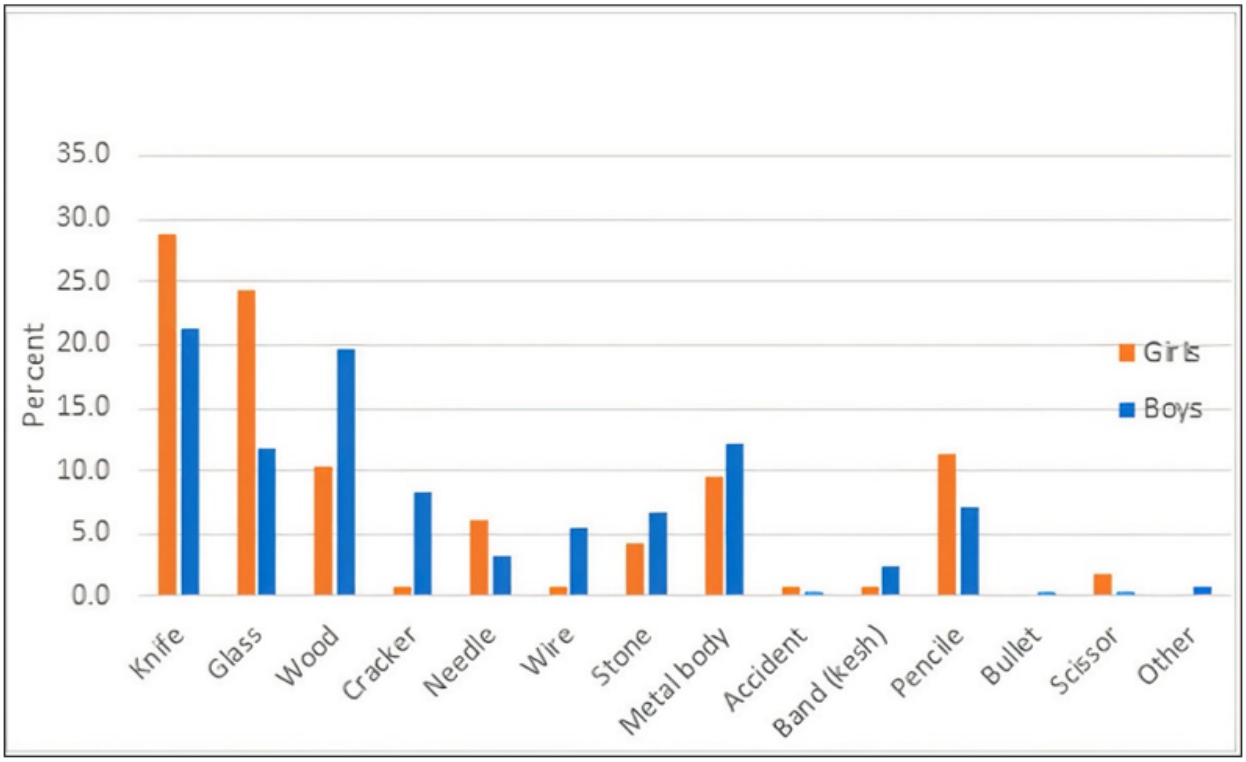

Figure 1: Distribution of mechanism causing trauma in girls and boys.