



RESEARCH

Clinical and epidemiological characteristics of pediatric patients with post-traumatic open globe injury

Travma sonrası açık glob yaralanması olan pediatrik hastaların klinik ve epidemiyolojik özellikleri

Gamze Yıldırım Biçer¹, Kürşad Ramazan Zor¹

¹Niğde Ömer Halisdemir University School of Medicine, Department of Ophthalmology, Niğde, Turkey

Abstract

Purpose: The aim of this study was to determine the epidemiology and clinical features of pediatric traumatic open globe injuries in our region.

Materials and Methods: Medical records of patients under the age of 18 who were diagnosed with open globe injury between January 2012 and December 2022 were retrospectively reviewed. Demographic data of the patients such as age, gender, time of injury, area of injury, type of injury, and cause of injury were recorded. Initial and final visual acuity and ocular findings at admission were recorded. Factors associated with final visual acuity were evaluated.

Results: The mean age of the patients was 7.62 ± 4.22 years. The majority of the patients were male (n=28, 66.7%). The right eye was the most injured (n=30, 71.4%). The initial visual acuity of approximately 72.5% (n=29) of the patients was worse than 20/200. And the final visual acuity of 50% of the patients (n=20) was below 20/200. The most common type of injury was penetrating trauma (n=18, 42.9%). The region with the highest trauma was Zone I (n=30, 71.4%). The most traumatic materials were metallic objects (n=13, 31%). The most common accompanying clinical finding was lens damage (n=18, 42.9%). Iris damage, lens damage, hyphema, vitreous hemorrhage, retinal detachment, endophthalmitis, type of injury, material causing the injury, and injury area were significantly associated with final vision.

Conclusion: In our region, open globe injuries were mostly observed in boys under 12 years in the pediatric age group. Penetrating and cutting metallic objects seem to be the most important cause of trauma. Parents and all caregivers should be informed of the seriousness of open globe injuries to prevent possible injuries.

Keywords: Emergency surgery, ocular trauma, open globe injury, pediatric traumas, vision loss

Öz

Amaç: Bu çalışmada bölgemizdeki pediatrik açık glob yaralanmalarının epidemiyolojisi ve klinik özelliklerini sunmaya çalıştık.

Gereç ve Yöntem: Ocak 2012 ile Aralık 2022 tarihleri arasında açık glob yaralanması tanısı alan 18 yaş altı hastaların tıbbi kayıtları retrospektif olarak incelendi. Hastaların yaş, cinsiyet, yaralanma zamanı, yaralanma bölgesi, yaralanma tipi ve yaralanma nedeni gibi demografik verileri kaydedildi. İlk ve son görme keskinlikleri ve başvuru anındaki oküler bulgular kaydedildi. Yaralanmaya eşlik eden oküler bulguların nihai görme seviyesi ile ilişkisi değerlendirildi.

Bulgular: Hastaların yaş ortalaması $7,62 \pm 4,22$ yıl idi. Hastaların çoğunluğu erkekti (n=28, %66,7). Sağ göz en çok yaralanan gözdü (n=30, %71,4). Hastaların yaklaşık %72,5'inin (n=29) başlangıç görme keskinliği 20/200'den daha kötüydü. Hastaların %50'sinin (n=20) nihai görme keskinliği ise 20/200'ün altındaydı. En sık görülen yaralanma tipi penetran travmaydı (n=18, %42,9). Travmanın en yoğun olduğu bölge Zon I (n=30, %71,4) idi. En fazla travmatizan obje metal nesnelere (n=13, %31), En sık eşlik eden klinik bulgu lens hasarıydı (n=18, %42,9). İris hasarı, lens hasarı, hifema, vitre hemorajisi, retina dekolmanı, endoftalmi, yaralanma tipi, yaralanmaya sebep olan materyal ve yaralanma yeri nihai görme ile anlamlı şekilde ilişkiydi.

Sonuç: Bölgemizde pediatrik yaş grubunda açık glob yaralanmaları en çok 12 yaş altı erkek çocuklarda izlenmektedir. Delici ve kesici metal cisimler travmanın önemli nedeni olarak görünmektedir. Ebeveynler ve tüm bakıcılar, olası yaralanmaları önlemek için açık glob yaralanmalarının ciddiyeti konusunda bilgilendirilmelidir.

Anahtar kelimeler: Acil cerrahi, oküler travma, açık glob yaralanması, pediatrik travmalar, görme kaybı.

Address for Correspondence: Gamze Yıldırım Biçer, Niğde Ömer Halisdemir University School of Medicine Department of Ophthalmology, Niğde, Turkey E-mail: gmz_y_06@hotmail.com

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INTRODUCTION

Ocular traumas might cause serious open-globe injuries in the pediatric population and might lead to monocular or binocular vision loss^{1,2}. The risk group was reported as boys between the ages of 7-11 in general². In children, the causes of open globe injuries are different from the adult population. While adults are generally exposed to occupational injuries, pediatric patients are generally traumatized by sharp objects such as glass, scissors, and knives^{3,4}.

Vision loss in the pediatric age period may lead to psychosocial problems, as well as functional visual loss, delaying the mental development and learning of the child². Having sufficient information about the epidemiology and mechanisms of open globe injury in pediatric patients is of great importance for eye health education. Therefore, revealing risk factors and prognostic factors can be a guide in determining preventive measures and treatment plans. These factors may have different results depending on the study region due to the sociocultural and economic differences between the communities. In the literature, many studies have been conducted on the etiology and risk factors of open globe injury in many countries such as the US, Malaysia, and Thailand^{2,3,4}. Similarly, in our country, demographic studies have been carried out in Bursa, Diyarbakır, and Kırkkale regions^{5,6,7}. Age, initial visual acuity, wound area, wound size, vitreous hemorrhage, retinal detachment, and endophthalmitis have been found by studies as several prognostic factors that affect final visual acuity².

Among the studies in our country, the study carried out in the geographically closest region to our region is the study of Oğurel et al. (in Kırkkale). According to the results of their study, trauma was most common in boys aged 6-10 years. The most common type of injury was corneal traumas, and the most common accompanying finding was hyphema. Also, it has been reported that toys were the most common cause of injury.⁵ The current study aims to describe the epidemiology of eye injuries in patients under the age of 18, who have been evaluated in the last 10 years in the Niğde Training and Research Hospital Ophthalmology Department, which is located in the Central Anatolia Region and provides health services for the surrounding provinces. No study has been conducted to examine pediatric open globe traumas in our region yet. This study examines the frequency

and causes of eye injuries in children and the risk factors associated with the occurrence of these injuries in our region and, thus, offers specific recommendations for the establishment of primary prevention measures.

MATERIALS AND METHODS

This descriptive study was conducted retrospectively by the ophthalmology department in Niğde Training and Research Hospital. The protocol of this study was approved by the ethics committee of Niğde Ömer Halisdemir University Faculty of Medicine (Date: 8.12.2022 Protocol No: 2022/115) and the study was conducted in accordance with the Helsinki Declaration.

Procedure

Medical records of patients under the age of 18 who were followed up for open globe injury (full-thickness laceration of the cornea or sclera) between January 2012 and December 2022 were retrospectively analyzed. The medical records of the patients were scanned by the researchers (GYB, KRZ) from the hospital registry system (KARMED), which each doctor uses with their own password. All patients under the age of 18 who were diagnosed with open globe injury and followed up for three months were included in the study. However, patients with loss of consciousness due to multiple trauma, whose visual acuity could not be measured, and who did not have follow-up examinations after three months were excluded from the study. Six patients were not included in the study due to exclusion criteria.

Data including demographic characteristics of the patients such as age and gender, type of injury, material causing the injury, injury area and the date of injury were collected. Patients included were examined in three groups according to their ages: 0-6 years, 7-12 years, and 13-17 years. Birmingham Eye Trauma Terminology system, which classifies mechanical eye traumas, was used to define the cases⁸. Accordingly, eye injuries are classified into two groups open and closed depending on the presence or absence of a full-thickness defect in the eye wall (sclera and cornea). Open injuries are then divided into four groups: Full thickness injuries caused by a blunt object (globe rupture), single and full-thickness penetrating injuries caused by sharp objects,

perforating injuries which have entry and exit sites, and injuries with intraocular foreign bodies.

The best-corrected visual acuity (BCVA) at admission, final BCVA, detailed ocular anterior and posterior segment evaluations, and other accompanying ocular findings at the time of admission (iris or lens damage, hyphema, vitreous hemorrhage, retinal detachment, endophthalmitis) were recorded in patients with open globe injury.

The location of the injury was defined according to the Ocular Trauma Classification⁹: zone I, limited to the cornea or limbus; zone II, limited to anterior 5 mm sclera; zone III, defects more than 5mm posterior to the limbus. The causes of injury were collected in nine groups: glass, metallic, plastic, wood, plant-tree, animal-human limbs, stone, unknown causes, and other sources. Final BCVA was evaluated from the examination obtained at least three months after the injury. Poor vision was defined as <20/200.

The time of admission to the hospital was divided into two groups: within the first 24 hours after the injury and more than 24 hours after the injury. The data on the injury date was collected in four groups of three months: January-February-March, April-May-June, July-August-September, and October-November-December.

The number of surgeries performed was analyzed in two groups: one surgery and more than one surgery. The relationship of the final BCVA with accompanying ocular findings (iris or lens damage, hyphema, vitreous hemorrhage, retinal detachment, endophthalmitis), type of injury, material causing the injury, injury area, and the number of surgery was evaluated.

Statistical analysis

SPSS version 25 statistical program was used to analyze statistics. Descriptive data were analyzed

using mean, and percentage as appropriate. Pearson Chi-square test were performed to compare qualitative data (between the final BCVA and the accompanying ocular findings, type of injury, material causing the injury, injury area). The statistical significance was set at p< 0.05.

Power analysis was conducted by using G*Power 3.1. Goodness-of-fit tests employed contingency tables as statistical tests. While df is 10, with alpha (α err prob) of 0.05 and power (1-β err prob) of 0.8, the actual power of the analysis was 0.969.

RESULTS

A total of 42 pediatric patients (42 eyes) diagnosed with open globe injury between January 2012 and December 2022 were included in the study. In this study, there were no patients with bilateral open globe injuries. The mean age of the patients was 7.62 ±4.22 years (distribution 1-17 years). The majority of the patients were male (n=28, 66.7%) and the male/female ratio was 2:1. 19 patients in the 0-6 age group, 17 patients in the 7-12 age group, and 6 patients in the 13-17 age group were included in the study.

The right eye was the most injured (n=30, 71.4%). The initial BCVA of 72.5% (n=29) of the patients was worse than 20/200. And the final BCVA of 50% of the patients (n=20) was below 20/200. There were two patients in the preverbal period in the study and vision evaluation could not be measured. The distribution of the initial and final vision of the patients is shown in Table 1. Only three patients did not apply to the hospital within the first 24 hours after the injury. Injuries mostly developed in the period covering October-November-December (n=14, 33.3%) (Table 2).

Table 1. Distribution of initial and final visual acuity according to age groups

Variable		Initial BCVA <20/200 n (%)	Final BCVA < 20/200 n (%)	Initial BCVA ≥20/200 n (%)	Final BCVA ≥20/200 n (%)
Age groups (years)	3-6	17 (45.2%)	11 (27.5%)	0 (0%)	6 (15%)
	7-12	10 (25%)	7 (17.5%)	7 (17.5%)	10 (25%)
	13-17	2 (5%)	2 (5%)	4 (10%)	4 (10%)

BCVA: best corrected visual acuity, n: number

Table 2. Characteristics of the pediatric open globe injury patients

Variable		Number (%)
Sex	Male	28 (66.7%)
	Female	14 (33.3%)
Side	Right	30 (71.4%)
	Left	12 (28.6%)
Hospital admission time	24 ≥	39 (92.9%)
	24<	3 (7.1%)
Time of injury	January-February-March	7 (16.6%)
	April-May-June	11 (26.1%)
	July-August-September	10 (23.8%)
	October-November-December	14 (33.3%)

Table 3. Characteristics of the injuries

Variable		Number (%)
Type of injury	Globe rupture	8 (%19)
	Penetrating injury	18 (%42.9)
	Perforating injury	9 (%21.4)
	Intraocular foreign body	7 (%16.7)
Injury area	Zone 1	30 (%71.4)
	Zone 2	4 (%9.5)
	Zone 3	8 (%19)
Cause of injury	Metallic objects	13 (%31)
	Glass objects	4 (%9.5)
	Plastic objects	4 (%9.5)
	Human or animal limbs	4 (%9.5)
	Stone	4 (%9.5)
	Others	4 (%9.5)
	Unknown	4 (%9.5)
	Plant or tree	3 (%7.1)
	Wooden objects	2 (%4.8)

Table 4. Factors associated with final vision

Variable		Number (%)	P
Iris damage	Yes	15 (35.7%)	0.000
	No	27 (%64.3%)	
Lens damage	Yes	18 (%42.9%)	0.001
	No	24 (%57.1%)	
Hyphema	Yes	17 (%40.5%)	0.000
	No	25 (59.5%)	
Vitreous hemorrhage	Yes	12 (28.6%)	0.000
	No	30 (71.4%)	
Retinal detachment	Yes	12 (28.6%)	0.000
	No	30 (71.4%)	
Endophthalmitis	Yes	8 (%19)	0.002
	No	34 (%81)	
Type of injury			0.012
Material causing the injury			0.000
Injury area			0.003
Initial visual acuity			0.077

The most common type of injury was penetrating trauma (n=18, 42.9%). There were 9 patients with perforating trauma (21.4%), 8 patients with globe ruptures (19%), and 7 patients with intraocular

foreign bodies (16.7%). Zone I was the most traumatized area (n=30, 71.4%). Zone II was the least traumatized area (n=4, 9.5%). Zone III injury was seen in 8 patients (19%). The most common traumatic materials were metallic objects (n=13, 31%) (Table 3). The most common accompanying clinical finding was lens damage (n=18, 42.9%), and the least common clinical finding was endophthalmitis (n=8, 19%) (Table 4). There were 31 patients (73.8%) who underwent single surgery after trauma and 11 patients (26.2%) who underwent multiple surgeries. Treatment of two children with firework injuries resulted in enucleation.

In Table 4, the factors related to the final vision were examined. There were significant relationship between the final vision and the presence of iris or lens damages, hyphema, vitreous hemorrhage, retinal detachment, and endophthalmitis. In addition, it was found that the injury area, injury type, and causative material had a significant effect on final vision.

DISCUSSION

Evaluation of open globe injuries in the pediatric population is generally difficult and these injuries can lead to poor visual prognoses. In this study, we aimed to present the demographic and clinical characteristics of pediatric patients with open globe injuries in our region to provide guidelines for precautions and treatment planning.

Similar to other studies, it was shown in our study that open globe injuries were more common in boys than in girls^{7,8}. In our study, while the male/female ratio was 2/1, this ratio was presented as 1.5-2.1 in other pediatric studies conducted in our country^{5,6,12}. More frequent injuries in boys were explained by their tendency to more dangerous and vigorous activities and the high risk of these activities in terms of eye trauma¹³. The mean age of our patients was 7.62 ± 4.22 , and in different studies in the literature, the mean age range was 7.48-9.3, although it varied according to the region of the study.¹⁴⁻¹⁵ The difference between the age groups may be the result of certain differences, such as geographical conditions, upbringing and lifestyle, and education level. In a study examining the pediatric population with open globe injury in Kırkkale region in our country, the mean age was found to be 7.63 ± 4.27 years, which is very similar to our study⁵. Again, in a study carried out in Diyarbakır, it was found to be 7.26 ± 3.80 years⁶. In a study conducted in Istanbul and its surroundings, it was found to be 4.38 years¹⁶.

In our study, the age group with the highest number of injuries was 0-6 age group and this is generally compatible with the literature. The least number of injuries was in the 12-17 age group. The high number of injuries in the preschool period may be due to the fact that children in this period are more curious and do not know how to protect themselves. In our study, it was found that the right eyes were most commonly affected. In our country, Oğurel et al.⁵ and Ava et al.⁶ reported that the right eyes were exposed more to open globe trauma while Çetin et al.¹² found that the left eyes were exposed more. Since children grasp objects with their dominant hand, the higher number of right-handed people may explain the higher probability of injury in the right eye. However, Choovuthayakorn et al.¹⁴ and Liu et al.¹⁷ reported that the left eyes were more affected in their pediatric study. The variety of trauma causes and trauma objects may be the cause of these differences. In our study, it was found that most injuries occurred in October-November-December. Liu et al.¹⁷ reported that injuries occurred most frequently in February, when the spring festival was celebrated in their country. Ava et al.⁶ reported that injuries were seen mostly between the fourth and sixth months. Injury dates differ according to the climate characteristics and life activities of the countries and regions. While traumas were generally seen in winter in our region, most eye injuries occurred during the summer months in Canada¹⁸. The increase in incidence in the winter months can be explained by the possibility of spending more time indoors due to seasonal conditions and increased exposure to sharps for our region.

In our study, the most common injury was seen in Zone 1 limited to the cornea, while the least injury was seen in Zone II covering 5 mm behind the cornea. Cornea is the most frequently damaged structure in open globe injuries due to its anterior location. In general, the cornea was reported as the most damaged zone in our country and the world^{16,17,19}. In our study, Zone II had the least injuries, while Batur et al.¹⁹, from our country, found that Zone III had the least injury in their study. The most common type of open globe injury in the literature is penetrating injuries²⁰. In our study, we found that penetration was the most common type of injury. Injuries were found to be mostly due to metallic objects in our study. It has been reported in the literature that the most common cause of open globe injuries in children is metal objects (knives, forks, etc.)²¹, which can be found easily in every

home. Contrary to our study, Choovuthayakorn et al.¹⁴ reported that injuries were most frequently caused by wooden objects. The reason for these differences in the causes of injury may be the region of residence, the age and, the activities of the patients. In our study, there were fireworks injuries in two children and ended with enucleation.

Factors associated with visual outcomes are variable in both adults and children. Initial visual acuity, mechanism of injury, site of injury, hyphema, endophthalmitis, vitreous hemorrhage, and retinal detachment are among the most studied factors⁷. According to our results, while there was no significant relationship with initial visual acuity, the presence of iris and lens damages, vitreous hemorrhage, retinal detachment and endophthalmitis had a significant relation with the final BCVA. In addition, the type of injury, material causing the injury and injury area were significantly associated with the final BCVA. However, we believe that, for more reliable results on associated factors, a larger number of patients should be examined. The most important limitation of our study was the small number of patients. This may be due to the relatively low population of Niğde. In this study, the most common ocular finding accompanying injuries was lens trauma. Saxiriwutto et al.² found no relationship between traumatic cataract and final vision. Xue et al.²² identified traumatic cataract as a poor prognostic factor. Liu et al.¹⁷ found no relationship between iris prolapse, lens damage, endophthalmitis, and final vision, and stated that hyphema, vitreous hemorrhage and retinal detachment were poor prognostic factors. In addition, Liu et al.¹⁷ indicated that hyphema, vitreous hemorrhage and retinal detachment may cause poor visual prognosis since they are usually associated with posterior segment injuries. In a Canadian study examining 131 pediatric open globe injuries; wound length, area of injury, vitreous hemorrhage, and retinal detachment were identified as risk factors for final visual acuity, but, it was reported that hyphema and lens damage were not risk factors²³. In a study conducted in Bursa, Yıldız et al., defined hyphema and retinal detachment as risk factors and demonstrated that lens and iris damages were not associated with final vision. Another study identified the mechanism of injury and the length of time before surgery as risk factors²⁴. In the study of Kadappu et al.²⁵, which analyzed the outcomes of open globe injuries in children, it was reported that wound length, wound site, and lens injury were risk factors for poor visual outcome.

Initial visual acuity was also reported to be predictive for visual outcome^{7,26}. However, having a reliable initial visual acuity in children is not always possible, especially after the trauma. This may cause the initial visual level to have a limited role in predicting the final visual acuity after injury. In our study, initial BCVA data of two patients could not be obtained, and no relation between initial visual acuity and final vision was found. Rudd et al.²⁷ demonstrated that for children, initial visual acuity was less valuable as a prognostic predictor of final vision than for adults. Batur et al.¹⁹ found a significant positive linear correlation between initial visual acuity and final visual acuity in a study they conducted on children. RAPD has been shown to be among the prognostic factors affecting the final visual acuity in open globe injuries²⁸. Our study could not provide information on this issue, since sufficient information could not be obtained about the presence of RAPD in the medical records. Pediatric ocular trauma score is a detailed measure of the future functional prognosis of the visual acuity in children with penetrating eye injury²⁹. Scoring was not used in our study due to the lack of sufficient information about iris prolapse in the medical records. This is another important limitation of our study. In addition, due to the lack of necessary equipment for vitreoretinal surgery, secondary surgeries other than primary repair could not be performed in our hospital. Therefore, the information about multiple surgeries could not be presented.

As far as we know, the study is the only study of childhood open globe injuries in our region. Since our study institution is the only hospital in Niğde that provides uninterrupted service for eye diseases, it provides reliable information about the region. However, being single-centered and having the small number of patients were important limitations of our study.

Consequently, open globe injuries are mostly observed in boys under 12 years of age in our region. Penetrating and cutting metallic objects seem to be the most important cause of the traumas. Injuries with explosive substances such as fireworks may result in enucleation. To reduce the incidence of traumatic eye injuries in the pediatric age, the type and risk factors of eye trauma should be well defined especially for each region, and social education on preventive measures is required. Multicenter studies with higher numbers of patients for pediatric open

globe injuries may provide more specific risk factors for our region.

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