Epidemiological and Clinical Characteristics of Childhood Open Eye Injuries in the South of Anatolia

Ayşe İdil Çakmak[1], Ahmet Kakaç[2], Zekeriya Kahveci[3], Veysel Cankurtaran[4], Sait Coşkun Özcan[1], Ahmet Elbeyli[1], Şirin Çetin[5]

ABSTRACT

Purpose: The aim of this study is to determine the demographic, epidemiological and etiological characteristics of pediatric patients presented with open eye injury (OEI).

Materials and Methods: We retrospectively reviewed medical records of the children who presented with OEI to a tertiary eye care center between January, 2017 and July, 2019. The cases were stratified into two groups as preschool (2-5years) and school-age (6-16years) children.

Results: The study included 39 eyes of 37 cases. The mean age was 7.38±4.01 years and male: female ratio was 1.85. The study included 22 eyes of 22 preschool and 17 eyes of 15 school-age children. It was seen that the most common OEIs were OEI by a sharp object (25 cases; 64.1%), penetrating OEI (35 cases; 89,7%), zone I OEI (19 cases; 48.7%), corneoscleral OEI (19 cases; 48.7)) and small OEI (<5 mm in size) (18 cases;46,2%). Intraocular foreign body was detected in 5 cases (12.8%). No significant relationship was found between lens damage and cause of trauma (p=0.427); whereas there was a significant correlation between size of injury and retinal detachment (p<0.0001 for both). It was found that there was bilateral OEI in 2 of 5 cases injured during the Syrian civil war and that 3 cases underwent evisceration.

Conclusion: Unlike the children who were seriously injured in the war environment, it was determined that children in peace environment were exposed to OEI with milder symptoms, mostly by preventable reasons. The results of this study show the severe effects of war on children; in addition, it may help to raise awareness and take first steps for prevention of OEI in children in peace.

Keywords: Eye injuries, open-globe injury, trauma.

INTRODUCTION

Ocular trauma is an important cause of decreased vision worldwide[1]. In developed countries, ocular trauma is the presenting complaint in almost one-half of patients presenting to eye clinics[2]. It was reported approximately 50% of ocular traumas are seen in children worldwide[3]. It was found that ocular traumas are the most common mono-ocular blindness in children[4-6].

Open eye injury (OEI) is a severe form of ocular trauma and an important cause of morbidity that threatens vision[7, 8]. The OEIs occurs as a result of full-thickness injury of eye globe[9, 10]. It leads decreased vision and pain in the children[11, 12]. This not only affects physical, psychological and social health of children but also cause labor loss and economical problems in the future[13, 14].

Our clinic is a part of a healthcare facility located in a border city at Eastern Anatolia where many casualties from Syrian civil war are presented[15]. The aim of the study was to assess the demographic, epidemiological and etiological characteristics of pediatric patients presented with OEI to our tertiary eye clinic.

MATERIALS AND METHODS

We retrospectively reviewed medical records of patients (aged <18 years) presented with OEI to our eye clinic of a tertiary healthcare center between January, 2017 and July, 2019. The study was approved by Institutional Ethics Committee (approval# 08-08-201-21). The study was conducted in accordance to tenets of Helsinki Declaration. All parents gave written informed consent before study.

1- MD, Assistant Prof., Mustafa Kemal University Tayfur Ata Sokmen Faculty of Medicine, Department of Ophthalmology, Hatay, Turkey

2- MD, Research Assistant., Mustafa Kemal University Tayfur Ata Sokmen Faculty of Medicine, Department of Ophthalmology, Hatay, Turkey

3- MD, Kandıra M. Kazım Dinç State Hospital, Clinic of Ophthalmology, Kandıra, Kocaeli

4- MD, Associate Prof. Mustafa Kemal University Tayfur Ata Sokmen Faculty of Medicine, Department of Ophthalmology, Hatay, Turkey,

5- Doctor lecturer, PhD,Tokat Gaziosmanpasa University Faculty of Medicine, Department of Biostatistics, Tokat, Turkey

Received: 15.01.2021
Accepted: 17.03.2021

Ret-Vit 2021; 30:271-280

DOİ: 10.37845/ret.vit.2021.30.47

Correspondence Adress:
Ayşe İdil Çakmak
Mustafa Kemal University Tayfur Ata Sokmen Faculty of Medicine, Department of Ophthalmology, Hatay,Turkey
Phone: +90 506 886 5944
E-mail: idilayse@yahoo.com

The inclusion criteria were:

1. Presence of full-thickness injury at cornea and/or sclera in accordance to OEI definition (9,10),

2. Presence of orbital and cerebral computed tomography obtained at time of presentation (before primary repair or evisceration surgery),

3. Initial surgical treatment for OEI in our clinic,

4. Available clinical record that included data regarding examination at presentation and surgical intervention.

We recorded demographic data including age and gender and penetrating or blunt objects as well as explosives such as bullet, bomb or mines which caused OEI. The trauma etiology were classified into 3 groups: penetrating eye injury with a sharp object, eye injury due to gun or explosives and injury by a blunt object.

Type of injury was defined as penetrating, perforating or rupture. The penetrating injuries are those resulting from penetration of a sharp object into eye globe: the injury was defined as penetration if only entry wound was present whereas perforation if both entry and exit wounds were present. The rupture was defined as presence of an opening at weakest point of eye globe resulting from blunt trauma[9, 10]. In addition, the OIEs were classified as corneal, corneoscleral and scleral according to localization of full-thickness injury in eye globe. Moreover, the wound site at eye globe was expressed as zone: zone 1, cornea and/or limbus; zone 2, scleral area 5 mm distal to limbus; and zone , scleral area extending to distal from zone 2[10, 16].

The visual acuity (VA) was assessed using Snellen charts during physical examination at presentation; VA values were recorded as decimals. In all patients, presence of lens injury, concurrent retinal detachment and intraocular foreign body (IOFB) were recorded according to biomicroscopic examination, ocular sonography and CT scan results; in addition, type of initial surgical intervention was also recorded.

The cases were stratified into two groups as preschool (2-5years) and school-age (6-16years) children. The trauma etiology, wound site (zone), localization and size of injury, VA at presentation, retinal detachment, lens trauma, IOFB and evisceration status were recorded in the groups. The descriptive statistics are presented as count (n), percent (%) and mean ± standard deviation. Categorical variables were analyzed using Chi-square test. All statistical analyses were performed using SPSS for Windows version 22.0. The statistical significance was assessed at alpha level of 0.05.

FINDINGS

The study included 39 eyes of 37 patients (aged <18 years) with OEI. The mean age was 7.38 ±4.01 years ranging from 2 to 17 years (Figure 1). It was seen that 29 (78.4%) of patients presented with OIE were children aged≤8 years and that the children aged 5 years were most often presented with OEI (12 children; 32.4%). It was also found that 81% of children (n=30) were aged <10 years. There were 24 boys (64.86%) and 13 girls (35.14%) in the study. The male: female ratio was 1.85). It was found that OEI was at right side in 25 eyes (64.1%). The study included 22 eyes of 22 preschool children (7 girls; female: male ratio, 2.14; mean age: 4.18±0.22 years) and 17 eyes of 15 school-age children (6 girls; female: male ratio, 1.50; mean age: 11.53±0.93 years).

Table 1 presents the objects caused injury. The penetrating objects defined by patients and their relatives included

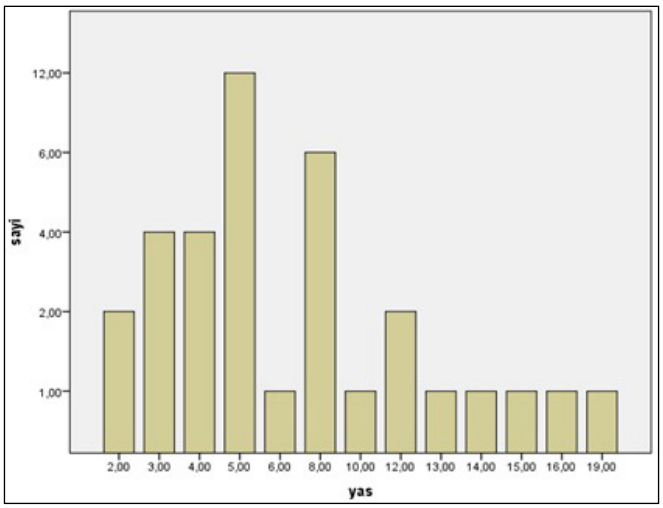

Figure 1: *Age distribution of the cases.*

Table 1: *Objects causing eye injury.*

Objects	n	%
Wooden (pencil, bar etc.)	4	10.3
Metal (bar etc.)	17	43.6
Bullet	3	7.7
Glass	4	10.3
Bomb-mine	4	10.3
Stone	2	5.1
Blunt (furniture, bank, floor, toy)	5	12.8
Total	**39**	**100,0**

knife, fork, iron bar, scissor, needle, glass and pen among others while blunt objects included toy, furniture (coffee table, bank etc.), stone and crown cap. It was observed that metal objects were most common cause of injury (17 cases, 43.6%).

Table 2 presents characteristics of open eye injury in the cases. The most common cause of trauma was OEI by a penetrating object (25 cases; 64.1%). It was found that number eyes injured by blunt object and gun-explosives were identical (7 cases for each; 17.9%). It was observed that the number of OEIs by a blunt object was significantly higher in preschool group when compared to school age group.

The visual acuity (VA) at presentation was classified as positive (P+) or negative (P-) light perception, hand movement (HM), <HM and ≤0.05; <0.05 and <0.5, and ≥0.5. The VA at presentation could not be assessed in 7 children (17.9%) due unconsciousness, problems in cooperation during examination and communication problems. VA at presentation ≥HM was detected in 21 eyes (53.8%). The VA at presentation <HM in all cases with OIE secondary to explosives and gunfire injury. The final VA was not included to the study due to short follow-up in most cases and lack of control visit in some cases.

Mostly, there were small corneoscleral OEI (<5 mm in size) at zone I (19 cases [48.7%], 19 cases [48.7%] and 18 cases [46.2%], respectively). It was found that injuries

Table 2: *Ocular characteristics of the patients with open eye injury in groups.*

Characteristics of Open Eye Injury		Patients					
		Preschool age		School age		Total	
		n	%	n	%	n	%
Cause of trauma	Sharp object	15	60	10	40	25	64.1
	Gunfire / Explosive	2	28.6	5	71.4	7	17.9
	Blunt object	5	71.4	2	28.6	7	17.9
Type of injury	Penetration	22	62.9	13	37.1	35	89.7
	Perforation	0	0	1	100	1	2.6
	Rupture	0	0	3	100	3	7.7
Size of injury	<5mm	11	61.1	7	38.9	18	46.2
	5-10 mm	8	53.3	7	46.7	15	38.5
	>10mm	3	50	3	50	6	15.4
Localization of injury	Corneal	11	64.7	6	35.3	17	43.6
	Corneoscleral	10	52.6	9	47.4	9	48.7
	Scleral	1	33.3	2	66.7	3	7.7
Zone	I	10	52.6	9	47.4	19	48.7
	II	10	62.5	6	37.5	16	41.0
	III	2	50	2	50	4	10.3
Visual acuity at presentation	≥0.5	0	0	3	100	3	7.7
	0.5-0.05	1	25	3	75	4	10.3
	Finger Count- 0.05	4	80	1	20	5	12.8
	EH	6	66.7	3	33.3	9	23.1
	P (+)	3	50	3	50	6	15.4
	P (-)	1	20	4	80	5	12.8
	Not assessed	7	100	0	0	7	17.9
Lens injury		8	53.3	7	46.7	15	38.5
Intraocular foreign body		2	40	3	60	5	12.8
Retinal detachment		3	37.5	5	62.5	8	20.5
Evisceration		1	33.3	2	66.7	3	7.7

HM +: Visual acuity higher than hand movement; **HM:** Hand movement; **P(+):** Positive light perception; **P (-):** Negative light perception.

caused by sharp objects and penetrating injuries were most common type of OEI (25 cases [64.1%] and 35 cases [89.7%], respectively).

It was found that there were IOFB in 5 eyes (12.8%), 3 (60%) of which was caused by injury due to explosives-gun (Figure 2). It was found that there were retinal detachment in 8 eyes (20.5%), 6 (75%) of which was injured by gun-explosives. Again, it was found that there were lens injury including anterior capsule tear or cataract in 15 eyes (38.5%). Primary surgical repair was performed in 36 eyes at presentation while evisceration surgery was performed in 3 eyes of 2 patients.

Of the cases included, it was found that there were 5 cases injured due to gunfire, explosives or mine blast during Syrian civil war. All these cases presented to our clinic a few days after injury. It was seen that OEI developed in both eyes in 2 cases. The first case was a 16-years old with bilateral OEI caused by mine blast. The other case was a 5-years old boy with unilateral OEI due to explosion. It was found that there were injuries >10 mm involving all 3 zones in 3 eyes of two patients who had VA of P (-) at presentation and underwent evisceration surgery. In addition, it was found that primary repair was performed in both eyes of a 15-years old girl with bilateral OEI due to explosion at Syria (Figure 3). There was unilateral OEI in all cases other than 2 cases with bilateral OEI due to civil war in Syria.

Figure 3: *Loss of volume in both eyes due to open eye injury and intraocular foreign body in right eye can be seen on axial section of of orbital computerized tomography scan.*

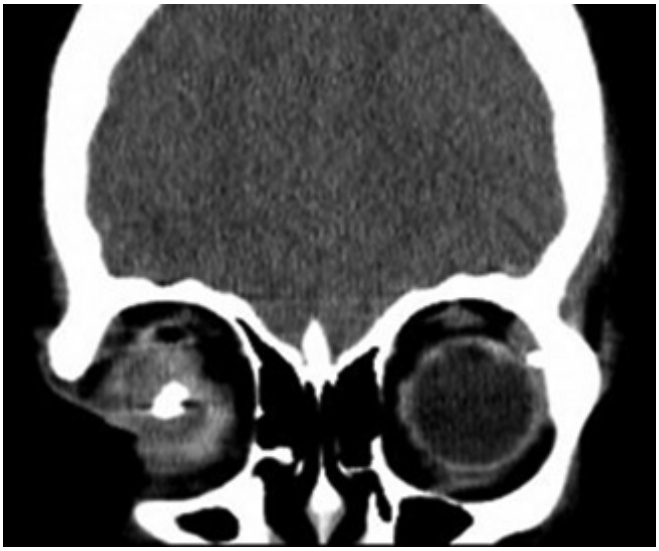

Figure 2: *Intraocular foreign body can be seen in left eyes on coronal section of orbital computerized tomography scan.*

Table 3 presents classification of OEI cases according to cause of trauma. When the association between injury site and cause of trauma was assessed, it was seen that all injuries due to gunfire or explosives involved both cornea and sclera while injuries due to sharp objects were mainly at cornea; followed by corneoscleral injury. It was found that there was corneoscleral injury in 5 (26.3%) of 7 eyes injured by blunt trauma. It was found that zone 3 was involved in all cases with OEI caused by gunfire and explosives (3 cases; 75%) while it was involved in only one case with penetrating OEI caused by sharp object. In statistical analyses, it was found that there was no significant correlation between cause of injury and lens injury ($p=0.427$) while there was a significant correlation between size and localization of injury and retinal detachment ($p<0.0001$ and $p<0.0001$, respectively). It was observed that injury size was >5 mm with retinal detachment in 6 (75%) of 7 eyes injured by gunfire and explosives. It was also found that 66.7% of eyes with injury size >10 mm were injured by gunfire and explosives (Figure 4). It was found that the injury size was <10 mm in all cases with OEI caused by blunt object and 23 of 25 cases with OEI caused by sharp object.

DISCUSSION

The open eye injury (OEI) is a severe form of ocular trauma and important cause of decreased vision and loss of vision worldwide[17-20]. In studies from Turkey and world, almost one-half of patients presenting with open eye injury were children[21, 22]. It was reported that OEI accounts for 19-60% of all ocular traumas among children, which was significantly higher than those among adult patients[8, 23-25]. In addition, it was found that 90% of OEIs

Table 3. *Comparison of ocular characteristics in patients with open eye injury according to cause of trauma.*

Characteristics of Open Eye Injury		Cause of trauma (n (%))			
		Sharp object	Gunfire-explosives	Blunt object	Total
Type of injury	Penetration	24 (68.6)	5 (14.3)	6 (17.1)	35
	Perforation	1 (33.3)	-	-	1
	Rupture	-	2 (66.7)	1 (100)	3
Size of injury	≤5 mm	14 (77.8)	1 (5.6)	3 (16.7)	18
	5-10 mm	9 (60)	2 (13.3)	4 (26.7)	15
	≥10 mm	2 (33.3)	4 (66.7)	-	6
Localization of injury	Corneal	15 (88.2)	-	2 (11.8)	17
	Corneoscleral	7 (36.8)	7 (36.8)	5 (26.3)	19
	SCleral	3 (100)	-	-	3
Zone	I	13 (68.4)	3 (15.8)	3 (15.8)	19
	II	11 (68.8)	1 (6.3)	4 (25)	16
	III	1 (25)	3 (75)	-	4
Visual acuity at presentation*	EH +	10 (83.3)	0	2 (16.7)	12
	EH	6 (66.7)	0	3 (33.3)	9
	P (+)	3 (50)	2 (33.3)	1 (16.7)	6
	P (-)	-	5 (41.7)	-	5
Lens injury		7 (46.7)	5 (33.3)	3 (20)	15
Intraocular foreign body		1 (20)	3 (60)	1 (20)	5
Retinal detachment		2 (25)	6 (75)	-	8
Evisceration		-	3 (100)	-	3

HM +: Visual acuity higher than hand movement; **HM:** Hand movement; **P(+):** Positive light perception; **P (-):** Negative light perception
*Visual acuity at presentation was not assessed in 7 cases

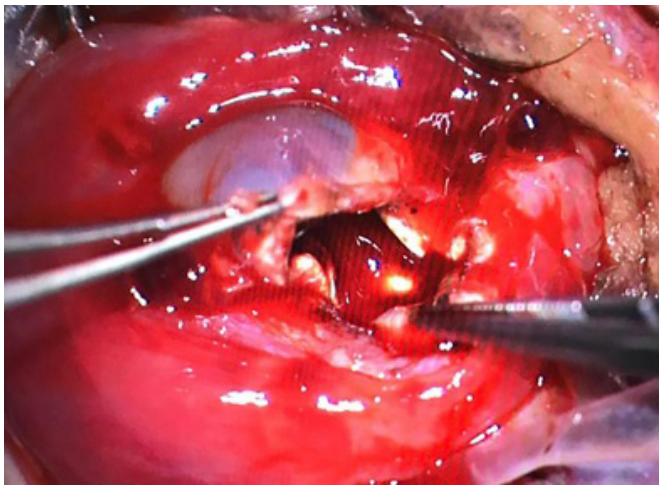

Figure 4: *Open eye injury (>10 mm in size) involving zone 3.*

in children were due to preventable causes[26, 27]. Thus, it is emphasized that the knowledge about demographic, etiological and epidemiological characteristics of children with OEI is important to identify children at risk and prevent accidents[28]. It was reported that OEI which impairs quality of life and causes labor loss has significant social and economic consequences for society[17]. In many studies on OEI worldwide, it was shown that there was male preponderance. In the literature, it is seen that male: female ratio varies 2:1 to 6:1[22, 29-33]. In the present study, male: female ratio was calculated as 1.85. In our study, it was found that M: F ratio was approximately identical in children at school age while it was higher in preschool age; however, it was emphasized that M: F ratio was increased by advancing age[34-36]. This may be due to fact that daily activities are similar between younger boys and girls while boys are tended to high-risk activities in advancing ages[35-39]. In a study by Hill et al., it was demonstrated that injury by blunt and sharp objects were more common in boys than girls[40]. However, in our study, no correlation was found between gender and cause of trauma.

In previous studies, it was seen that younger children were subjected to more ocular trauma[38-40]. However, some studies from Turkey and other countries reported contradictory results[37,41]. In our study, it was found that more than one-half of all patients were preschool children. In studies in which children were stratified as preschool

age, school age and adolescent, it was found that the number of children with OEI were higher among preschool age group; followed by school age group and adolescent group[42, 43]. This is explained by younger children acting in an inattentive manner and awareness of potentially harmful objects such as sharp objects among older children. In addition, some authors suggested that younger children have poorer manipulative skills than older children, increasing likelihood of injury in the eye[38-40].

It has been reported that pediatric cases are more frequently exposed to penetrating OEI by sharp and objects such as knife worldwide[4, 20, 22, 44-47]. In a study from Nigeria, it was reported that the injury occurred due to penetration of a sharp object into eye globe in all children presented with OEI during 16-years follow-up[48]. In a study from Iran, Hosseine et al. assessed 278 children (aged<15 years) with OEI including 6 severe ocular injury. Authors reported that OEI occurred in 73% of cases and that penetrating eye injury occurred by a metal object such as knife in majority of the cases[49]. Similarly, in a study from USA, it was reported that OEI occurred due to penetrating injury in 76% of the children presented during 12-years of study period[40]. In our study, it was found that penetrating eye injury due to trauma caused by a sharp object was the most common type of trauma in children presented with OEI in agreement with literature. The sharp objects included tools such as knife, fork, needle, scissor, glass, pen and bars. The objects were mainly metal (17 cases, 43.6%). Similar findings were reported in many studies investigating open eye injury in children from Turkey. Tok et al. found that there was penetrating eye injury in 81.7% of cases and that the most frequent cause of injury was self-injury by a sharp object or injuries caused by objects thrown by other children[42]. In addition, authors reported that injuries by sharp, metal objects such as knife, scissor, fork, nail and wire were more common (31.7%). Ilhan et al. showed that the rate of children with OEI due to penetrating injury was 48.9% among all patients and that stinging of metal object was most common cause of trauma in the etiology[34]. Similarly, Yildiz et al. suggested that penetrating objects such as pencil and knife were most common objects leading pediatric OEI while Cetin et al. suggested that wooden objects were more common[50, 51].

In a literature review on pediatric OEI including 105 studies over 20 years, it was reported that the second most common cause of OEI was rupture secondary to blunt trauma in children[52]. There are studies reporting similar studies from Turkey[42]. In our study, it was observed that rupture developed mainly due to explosives; however, preschool age children exposed to trauma caused by blunt objects such as toy, stone or furniture. This suggests that preschool age children exposed to such accidents because of immature neuromotor development in these children[38-40].

On the other hand, in the studies from different regions of Turkey, it was reported that older children more frequently exposed to penetrating eye injury with penetrating objects such as wood or metal bars in non-domestic environment, particularly in the absence of a caregiver, when compared to smaller children[42, 51]. Thus, it seems more appropriate to keep such objects away from children or allow their use under supervision. In a study from tertiary healthcare in South Africa, it was shown that penetrating OEI was developed in the absence of a caregiver in 85% of children exposed to ocular trauma with a sharp object[53].

In a study on pediatric OEI cases, Li et al. showed that there was no statistical difference regarding gender in eyes with OEI[52]. Similarly, it was reported that both eyes were evenly affected in a study investigating clinical and demographic characteristics of OEI[53-55]. In the literature, there are studies reporting that left eye was more commonly involved among cases with OEI[21, 48]. However, there are studies indicating the right eye was more commonly involved in the literature. For instance, Rostomian et al. reported that OEI occurred in 60% of eyes with OEI in the children[56]. In a study from Turkey, Ilhan et al. reported that right eye was more severely affected in 61.1% of eyes in pediatric OEI cases; however, the difference was markedly decreased in older age[34]. In addition, Tok et al. estimated that right eye was injured in 64.6% of patients[42]. As found in our study, the most frequent involvement of right eye by OEI may be due to higher right hand dominancy in the society[57].

In general, it was observed that laceration was most frequently localized cornea in children with OEI in the studies worldwide[22, 34, 55,58-61]. On contrary, it was found that corneoscleral laceration was more common injury, followed by corneal laceration in our study. Obajo et al. reported that corneoscleral laceration were more common in children while Knyazer et al. reported that corneal and scleral lacerations were evenly distributed in children[48, 62].

In retrospective studies from world, it was shown that zone 1 was affected in 45-80% of eyes in pediatric OEI cases[4, 22, 44, 45, 63-65]. In the studies from Turkey, it was reported that zone 1 was more commonly involved region in ocular injuries[34, 42, 60]. In our study, it was found that almost one-half injuries involved zone 1. It was observed that penetrating injuries with a sharp object was more commonly localized at zone 1 while zone 2 was involved in more than one-half of injures with blunt object and that corneoscleral injuries occurred more frequently in blunt objects. It was also

found zone 3 was more commonly affected in ocular injury by gunfire and explosives when compared to other injuries. In a study from Antalya province, Ilhan et al. reported that injury most often occurred at zone 1 in children with OEI[34]. In their study, they reported that ocular injury due to explosives occurred in only 6.7% of patients while this rate was 17.9% in our study. This may be due to fact that our clinic located at a border province serves children injured by explosives such as bullet, bomb or mine in Syrian civil war.

In a study investigating patients presented with OEI to a tertiary military hospital in Turkey, Guven et al. reported that 48.2% of these injuries were terrorism-related traumas and that mine blast or hand grenade explosion was more common cause of injury and zone 3 was affected bilaterally in more than one-half of patients (51.2%)[66]. In addition, they reported that zone 3 injuries accompanied to lens injury in 64.5% of eyes and that evisceration or enucleation was performed in 11.9%. moreover, bilateral OEI was present in 24.3% of patients. On contrary to our study, they found that only 10.5% were pediatric cases and showed how terrorism-related open eye injury might be severe. In a review including children injured by explosives in several countries with ongoing civil war such as Syria, Afghanistan, Israel and Bosnia, it was reported that bilateral OEI was present in 14% of children injured with explosives such as mine blast or hand grenade explosion and that these patients underwent evisceration or enucleation surgeries[67].

In our study, it was found that injury involved zone 3 in all eyes underwent primary evisceration surgery at presentation. In these eyes, gunfire and/or explosives were cause of trauma in 3 eyes while bilateral OEI occurred due to mine blast in one patient. In addition, it was found that VA at presentation was P (-) in all eyes with OEI underwent evisceration with zone 3 involvement. Similarly, in the study including cases with VA of (P-) at presentation, Soni et al. zone 3 injury was common characteristics of OEI cases scheduled to enucleation at presentation[68]. In a study from Turkey, Ozal et al. reported that zone 3 was frequently involved in Syrian patients presented with OEI to Kilis (44.2%) and that VA at presentation was <0.1 in 95.4% of the cases with 4 patients (9.3%) underwent evisceration due to complete rupture of eye globe[69]. Given that evisceration or enucleation surgery was performed in 8.75% of casualties due to explosive in Croatia civil war and 5.7% of casualties injured in Israel-Lebanon war, authors reported that the number of evisceration in their was in agreement with outcomes presented in the studies including eyes injured during war[70, 71]. There were OEI cases with laceration >10 mm which was involved zone 3 and scheduled to evisceration or enucleation surgery in studies on children living at peaceful environment. Comez et al. reported that evisceration was performed in one of 237 patients while Hill et al. reported evisceration in 2 (7%) of 59 eyes[60, 40]. In our study, evisceration surgery was performed in 3 eyes, comprising 7.7% of all patients. However, 2 of 3 eyes injured with explosives were in one patient and both cases were presented to our clinic due to OEI by mine blast or explosion from Syria.

It was reported that there was IOFB in 26-53% of eyes injured due to explosives in war environment[70-74]. This rate was significantly higher than those observed in peaceful environment (6-41% of OEI cases[45, 75]. In a study, Ozal et al. there was IOFB in one-half of eyes (51.2%) presented with OEI in Syrian civil war[69]. In our study, it was seen that OEI occurred due to gunfire injury or explosives in 3 of 5 eyes in agreement with literature. In the study investigating terrorism-related OEI, Guven et al. emphasized that there was IOFB in 42.1% of eyes with OE[66]. Authors emphasized that this rate was markedly higher than those reported in the literature74,76. Similarly, Gundogan et al. OEI cases involving all zones were commonly seen in soldiers with OEI due to terrorism and that there was accompanying IOFB in 95.7% of these injuries[77]. In these reports, the injury was due to mine blast in one-half of patients whereas due to bomb explosion and other explosives in remaining patients.

In the literature, a negative correlation was shown between zone 3 injury and visual prognosis[66, 78, 79, 80]. Based on this result, prognosis is poorer when injury is more distal to limbus. Also, there are studies indicating that visual prognosis was significantly associated with VA at presentation and size of injury[34, 60]. Grieshaber et al. reported that zone 1 was the most commonly involved area and that laceration was <5 mm in children presented with penetrating eye injury[53]. In the study, authors found that visual acuity was ≥0.5 in 66.7% when visual prognosis was prospectively evaluated children with OEI. In a study by Thomson et al., laceration was often smaller than 5 mm (38%) but number of patients with OEI of 5-10 was similar (33%)[35]. Unlike our study, the effects of these factors on visual prognosis were assessed in these studies; however, whether there is a relationship between cause of trauma and size of injury hasn't been investigated. In our study, it was found that size of laceration causing injury was <5 mm in most cases. In addition, a significant correlation was detected between injury size and cause of trauma ($p<0.0001$). based on these results, laceration size was <10 mm in majority of eyes injured by a sharp object and that

laceration size > 5mm in almost all eyes injured secondary to explosion. It was also found that gunfire injury and explosives were the cause of injury in 66.7% of eyes with laceration >10 mm.

In previous studies, it was reported that concurrent retinal detachment and lens injury at presentation is effective in visual prognosis[53, 80, 81]. Thus, we calculated frequency of retinal detachment and anterior capsule rupture or traumatic cataract, which were found to be 20.5% and 38.5%, respectively. In studies from Turkey, retinal detachment rate varied from 4% to 26% in children with OEI[21, 34, 42, 54, 55, 60, 82]. Again, the rate of OEI cases with concurrent lens injury secondary to anterior capsule rupture or traumatic cataract varied from 10% to 46%[34, 42, 54, 60, 82]. In our study, no significant correlation was found between cause of trauma and lens injury while a significant correlation was found between cause of trauma and retinal detachment. In particular, it was shown that the OEI developed secondary to gunfire injury or explosives in 6 (75%) of 8 eyes with retinal detachment. It was also found that injury involved zone 3 in these eyes with retinal detachment. This result is in agreement with the study by Arroyo et al. reporting that concurrent retinal detachment was present in 40-50% of posterior OEI cases involving zone 3[83].

It was reported that the factors influencing on visual prognosis included mode, size and location of injury, concurrent retinal detachment, lens injury and VA at presentation[84, 85]. Thus, we assessed VA at presentation in our study. It was found that VA at presentation was less than HM in patients with OEI secondary to gunfire injury and explosives while it was >HM in children presenting with penetrating eye injury. In a study on children with penetrating OEI by sharp objects, Ozturk et al. found that VA at presentation was better than light perception in majority of children while it was P (-) in 3 patients[85]. Similarly, in a regression analysis evaluating visual prognosis, Gursoy et al. found that visual prognosis was better in penetrating OEI[86]. In some studies from Turkey, penetrating eye injuries frequently occurred due to traumas involving zone 1; followed by traumas involving zone 2 and visual prognosis was better in these eyes than eyes with zone 3 injury[50, 44, 55]. In our study, the zone 3 was involved by 3 of 5 cases with OEI secondary due to gunfire injury and explosives while zone 1 and 2 were most frequently involved in cases with penetrating OEI by sharp objects.

This study has some limitations including retrospective nature and small sample size. On the other hand, the strength of our study was evaluation of factors such as cause of trauma, type, size and location of injury, retinal detachment, lens injury and VA at presentation which are shown to affect visual prognosis. Due to short follow-up and lower rate of control visits, failure to include final VA to the study is an important limitation.

CONCLUSION

In conclusion, it is striking that number of children exposed to devastating effects of civil war was significantly higher in our study. On the other hand, it was found that children had OEI with milder symptoms and preventable causes of trauma in most instances in peaceful environment. The available results may help parents and caregivers to act in a more careful manner, to increase awareness for prevention of OEI and to take appropriate measures.

Acknowledgment

We acknowledge to Yusuf Kibar, MD for efforts in the diagnosis, treatment and follow-up of the cases in this study.

FUNDING

No funding or no medical devices, source or material or support for analysis was received from sources having direct interest in the topic of the study.

Conflict of Interest

The authors declare no conflict of interest including potential of discovery of authors and/or family members, membership of scientific committee or relationship with members, consultancy, expertise, employment, shareholding or other types of relationship with a company.

REFEDERCEZ

1. Négrel AD, Thylefors B. The global impact of eye injuries. Ophthalmic Epidemiol. 1998; 5:143-69.
2. Chiapella AP, Rosenthal AR. One year in an eye casualty clinic. Br J Ophthalmol. 1985; 69:865-70.
3. Rapoport I, Romen M, Kinek M, et al. Eye injuries in children in Israel. A nationwide collaborative study. Arch Ophthalmol. 1990; 108:376-379.
4. Narang S, Gupta V, Simalandhi P, et al. Paediatric open globe injuries. Visual outcome and risk factors for endophthalmitis. Indian J Ophthalmol. 2004; 52:29-34.
5. Strahlman E, Elman M, Daub E, et al. Causes of pediatric eye injuries. A population based study. Arch Ophthalmol. 1990; 108:603-606.
6. Lithander J, Al Kindi H, Tonjum AM. Loss of visual acuity due to eye injuries among 6292 school children in the Sultanate of Oman. Acta Ophthalmol Scand. 1999; 77:697-99.
7. Parver LM, Dannenberg AL, Blacklow B, et al. Characteristics and causes of penetrating eye injuries reported to the National Eye Trauma Registry, 1985-1991. Public Health Rep 1993; 108: 625-30.

8. Pieramici DJ, MacCumber MW, Humayun MU, et al. Open globe injury. Update on types of injuries and visual results. Ophthalmology. 1996; 103(11):1798-803.

9. Kuhn F, Morris R, Witherspoon CD, et al. A standardized classification of ocular trauma. Ophthalmology. 1996; 103:240-243.

10. Pieramici DJ, Sternberg P Jr, Aaberg TM Sr, et al. A system for classifying mechanical injuries of the eye (globe). The Ocular Trauma Classification Group. Am J Ophthalmol. 1997; 123:820-831.

11. Brophy M, Sinclair SA, Hostetler SG, et al. Pediatric eye injury related hospitalizations in the United States. Pediatrics. 2006; 117:1263-71.

12. Thylefors B. Epidemiological patterns of ocular trauma. Aust N Z J Ophthalmol. 1992; 20:95-8.

13. Hsieh DA, Stout JW, Lee RB, Gaydos JC. The incidence of eye injuries at three U.S. Army installations. Mil Med. 2003; 168:101-5.

14. Wong TY, Klein BE, Klein R. The prevalence and 5-year incidence of ocular trauma. The Beaver Dam Eye Study. Ophthalmology. 2000; 107:2196-202.

15. Kahraman A, Özkan M, Durmus M. Child injuries in the Syrian Civil War. Turk J Plast Surg. 2019; 27:123-6.

16. Augsburger JJ, Corrêa ZM. Ophthalmic trauma. In: Vaughan & Asbury′s General Ophthalmology. 18 th ed. New York: McGraw-Hill; 2011.

17. Negrel AD, Thylefors B. The global impact of eye injuries. Ophthalmic Epidemiol. 1998;5: 143-69.

18. De Juan Jr E, Sternberg Jr P, Michels RG. Penetrating ocular injuries. Types of injuries and visual results. Ophthalmology. 1983; 90: 1318-1322.

19. Spiegel D, Nasemann J, Nawrocki J, et al. Severe ocular trauma managed with primary pars plana vitrectomy and silicone oil. Retina 1997; 17: 275-285.

20. Jandeck C, Kellner U, Bornfeld N, et al. Open globe injuries in children. Graefes Arch Clin Exp Ophthalmol. 2000; 238: 420-426.

21. Özdemir M, Yaşar T, Şimşek Ş, et al. Göz Travması Olgularımızın Epidemiyolojik Değerlendirmesi. Van Tıp Dergisi. 2002; 9: 6-11.

22. Kadappu S, Silveira S, Martin F. Aetiology and outcome of open and closed globe eye injuries in children. Clin Exp Ophthalmol. 2013; 41:427-34.

23. Brinton GS, Topping TM, Hyndiuk RA, et al. Post traumatic endophthalmitis. Arch Ophthalmology. 1984; 102:547-50.

24. Niranen M, Raivio I. Eye injuries in children. Br J Ophthalmol. 1981; 65:436-38.

25. Peyman GA, Carol CP, Raichand M. Prevention and management of traumatic endophthalmitis. Ophthalmology. 1980; 87:320-29.

26. Kaur A, Agrawal A. Paediatric ocular trauma. Curr Sci. 2005;89(1):43-6.

27. Nelson LB, Wilson TW, Jeffers JB. Eye injuries in childhood: demography, etiology and prevention. Pediatrics. 1989;84:438-41.

28. Serrano JC, Chalela P, Arias JD. Epidemiology of childhood ocular trauma in a northeastern Colombian region. Arch Ophthalmol. 2003; 121(10): 1439-45.

29. Beshay N, Keay L, Dunn H, et al. The epidemiology of Open Globe Injuries presenting to a tertiary referral eye hospital in Australia. Injury. 2017;48:1348-54.

30. Casson RJ, Walker JC, Newland HS. Four-year review of open eye injuries at the Royal Adelaide Hospital. Clin Exp Ophthalmol. 2002;30:15-8.

31. Rofail M, Lee GA, O'Rourke P. Prognostic indicators for open globe injury. Clin Exp Ophthalmol. 2006;34:783-96.

32. Smith AR, O'Hagan SB, Gole GA. Epidemiology of open- and closed-globe trauma presenting to Cairns Base Hospital, Queensland. Clin Exp Ophthalmol. 2006;34:252-9.

33. Howden J, Danks J, McCluskey P, et al. Surfboard-related eye injuries in New South Wales: a 1-year prospective study. Med J Aust. 2014;201: 532-44.

34. Ilhan HD, Bilgin AB, Cetinkaya A, et al. Epidemiological and clinical features of paediatric open globe injuries in southwestern Turkey. Int J Ophthalmol. 2013;18;6:855-60.

35. Thompson CG, Kumar N, Billson FA, Martin F. The aetiology of perforating ocular injury in children. 2002;86:920-922.

36. Soylu M, Sizmaz S, Cayli S. Eye injury (ocular trauma) in southern Turkey: epidemiology, ocular survival, and visual outcome. 2010;30:143-148.

37. Turgut S, Perente I, Ozgun C, et al. Pediatric penetrating eye traumas: Risc factors. Turkish Journal of Trauma Emergency Surgery. 1997;3:58-61.

38. Baxter RJ, Hodgkins PR, Calder I, et al. Visual outcome of childhood anterior perforating eye injuries: prognostic indicators. Eye. 1994;8:349-352.

39. Rudd JC, Jaeger EA, Freitag SK, et al. Traumatically ruptured globes in children. J Pediatr Ophthalmol Strabismus. 1994;31:307-311.

40. Hill JR, Crawford BD, Lee H, et al. Evaluation of open globe injuries of children in the last 12 years. Retina. 2006;26:S65-8.

41. Moreira CA Jr, Debert-Ribeiro M, Belfort R Jr. Epidemiological study of eye injuries in Brazilian children. Arch Ophthalmol. 1988;106:781-4.

42. Tok O, Tok L, Ozkaya D, et al. Epidemiological characteristics and visual outcome after open globe injuries in children. 2011;15:556-561.

43. Cariello AJ, Moraes NS, Mitne S, et al. . Epidemiological findings of ocular trauma in childhood. Arq Bras Oftalmol. 2007;70:271-5.

44. Lesniak SP, Bauza A, Son JH, et al. Twelve-year review of pediatric traumatic open globe injuries in an urban U.S. population. J Pediatr Ophthalmol Strabismus. 2012;49:73-9.

45. Lee CH, Lee L, Kao LY, et al. Prognostic indicators of open globe injuries in children. Am J Emerg Med. 2009;27:530-5.

46. Kyari F, Mahmoud B, Alhassan, Abiose A. Pattern and outcome of paediatric ocular trauma, A 3-year review of national eye centre Kaduna. Nig J Ophthalmol. 2000;8:11-6.

47. Shoja MR, Shanavazi A. Evaluation of ocular trauma in 353 patients admitted to Ophthalmic Department Yazd. Jshahid Sadoughi Univ Med Sci Spring. 1998;4:18-26.

48. Ojabo CO, Malu KN, Adeniyi OS. Open globe injuries in Nigerian children: Epidemiological characteristics, etiological factors, and visual outcome. Middle East Afr J Ophthalmol 2015; 22:69-73.

49. Hosseini H, Masoumpour M, Keshavarz-Fazl F, et al. Clinical and epidemiologic characteristics of severe childhood ocular injuries in southern iran. Middle East Afr J Ophthalmol. 2011;18:136-40.

50. Yıldız BK, Çakır İ, Beşek NK, et al. [Pediatric Open Glob Injuries: Clinical Features and Long-Term Results]. Turkiye Klinikleri Oftalmoloji Dergisi. 2020;29:181-6.

51. Çetin EN, Saraç G, Kaşikçi A, et al. Epidemiologic and clinical features of open globe injuries in childhood. Turk J Ophthalmol. 2012;42:16-19.

52. Li X, Zarbin MA, Bhagat N. Pediatric open globe injury: A review of the literature. J Emerg Trauma Shock. 2015;8:216-23.

53. Grieshaber MC, Stegmann R. Penetrating eye injuries in South African children: aetiology and visual outcome. Eye (Lond). 2006 Jul;20:789-95.

54. Gümüş: K, Topaktaş D, Arda H, et al. [Clinical and Demographic Properties Penetrating Eye Injuries Occured in Childhood]. Turkiye Klinikleri J Ophthalmol 2009;18:7-12.

55. Niyaz L. [Open Globe Injuries in Childhood: Etiology and Results]. Çocukluk Çağı Delici Göz Yaralanmaları: Sebepler ve Sonuçlar. Abant Tıp Dergisi 2017;6:59-63.

56. Rostomian K, Thach AB, Isfahani A, et al. Open globe injuries in children. J AAPOS. 1998;2:234-8.

57. Leong CK. Laterality and Reading Proficiency in Children. Reading Research Quarterly. 1980;15: 185-202

58. Kamış Ü, Pekel H, Öztürk BT, et al.[Evaluation of Clinical Characteristics of Globe Lacerations]. Selcuk Tıp Derg. 2006;22:63-8.

59. Lee CH, Su WY, Lee L, et al. Pediatric ocular trauma in Taiwan. Chang Gung Med J. 2008;31:59-65.

60. Çömez A, Gürler B. [Investigation of Epidemiological Properties and Prognostic Factors in Patients with Open Glob Injuries]. Turkiye Klinikleri Oftalmoloji Dergisi. 2020;29:278-87.

61. Behbehani A, M, Lotfy N, Ezzdean H, et al. Abul N: Open Eye Injuries in the Pediatric Population in Kuwait. Med Princ Pract. 2002;11:183-189.

62. Knyazer B, Bilenko N, Levy J, et al. Open globe eye injury characteristics and prognostic factors in southern Israel: a retrospective epidemiologic review of 10 years experience. Isr Med Assoc J. 2013;15:158-62.

63. Saxena R, Sinha R, Purohit A, et al. Pattern of pediatric ocular trauma in India. Indian J Pediatr. 2002;69:863-7.

64. Chakraborti C, Giri D, Choudhury KP,et al. Paediatric ocular trauma in a tertiary eye care center in Eastern India. Indian J Public Health 2014;58:278-80.

65. Liu X, Liu Z, Liu Y, et al. Determination of visual prognosis in children with open globe injuries. Eye (Lond) 2014;28:852-6.

66. Guven S, Durukan AH, Erdurman C, et al. Prognostic factors for open-globe injuries: variables for poor visual outcome. Eye (Lond). 2019;33:392-397.

67. Milwood Hargrave J, Pearce P, Mayhew ER, et al. Blast injuries in children: a mixed-methods narrative review. BMJ Paediatr Open. 2019;3: e000452

68. Soni NG, Bauza AM, Son JH, et al. Open globe ocular trauma: functional outcome of eyes with no light perception at initial presentation. Retina. 2013;33:380-6.

69. Özal SA, Özal E. [Open Globe Eye Injuries from Syrian CivilWar]. Turkiye Klinikleri J Ophthalmol. 2015;24:90-4.

70. Plestina-Borjan I, Medvidovic-Grubisic M, Zuljan I, et al. Wartime open globe eye injuries. Graefes Arch Clin Exp Ophthalmol. 2010;248:305-12.

71. Barak A, Elhalel A, Pikkel J, et al. Incidence and severity of adnexal injuries during the Second Lebanon War among Israeli soldiers and civilians. Graefes Arch Clin Exp Ophthalmol. 2011;249:1771-4.

72. Gombos GM. Ocular war injuries in Jerusalem during the 1967 Arab-Israeli conflict. Am J Ophthalmol. 1969;68:474-8.

73. Duke-Elder S. Perforating wounds of eye. System of Ophthalmology. Vol 14. 2nd ed. UK: H. Kimpton; 1972. 323-46.

74. Sobaci G, Mutlu FM, Bayer A, et al. Deadly weapon-related open globe injuries: outcome assessment by the ocular trauma cllassification system. Am J Ophthalmol. 2000;129:47-53.

75. Gaudio AR. Intraocular foreign bodies. In: Albert DM, Jacobiec FA, eds. Principles and Practice of Ophthalmology. 2nd ed. Philadelphia: WB Saunders Company; 2000, 2514-30.

76. Thach AB, Johnson AJ, Carroll RB, et al. Severe eye injuries in the war in Iraq, 2003-5. Ophthalmology. 2008;115:377-82.

77. Gundogan FC, Akay F, Yolcu U, et al. Ocular blast injuries related to explosive military ammunition. J R Army Med Corps. 2016;162:39-43.

78. Liu ML, Chang YS, Tseng SH, et al. Major pediatric ocular trauma in Taiwan. J Pediatr Ophthalmol Strabismus. 2010;47:88-95.

79. Sheard RM, Mireskandari K, Ezra E, et al. Vitreoretinal surgery after childhood ocular trauma. Eye (Lond). 2007;21:793-8.

80. Esmaeli B, Elner SG, Schork MA, et al. Visual outcome and ocular survival after penetrating trauma. A clinicopathologic study. Ophthalmology. 1995;102:393-400.

81. Wang NK, Chen YP, Yeung L, et al. Traumatic pediatric retinal detachment following open globe injury. Ophthalmologica. 2007;221:255-63.

82. Acar U, Tok OY, Acar DE, et al. A new ocular trauma score in pediatric penetrating eye injuries. Eye (Lond). 2011;25:370-4.

83. Arroyo JG, Postel EA, Stone T, et al. A matched study of primary scleral buckle placement during repair of posterior segment open globe injuries. Br J Ophthalmol 2003;87:75-8.

84. Dürük K, Budak K, Turaçlı E, et al. [Prognostic factors in penetrating eye injuries.] T Oft Gaz. 1994;24:216-9.

85. Ozturk T, Cetin Dora G, Ayhan Z, et al. Etiology and Visual Prognosis in Open Globe Injuries: Results of A Tertiary Referral Center in Turkey. Sci Rep. 2019;29;9:17977.

86. Gursoy H, Bilgec MD, Sahin A, et al. A Possible Regression Equation for Predicting Visual Outcomes after Surgical Repair of Open Globe Injuries. J Ophthalmol. 2017;2017:1320457.