·Clinical Research·

Epidemiological and clinical features of paediatric open globe injuries in southwestern Turkey

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Received: 2013-07-23 Accepted: 2013-08-28

Abstract

• AIM: To evaluate the epidemiologic, anatomic, and clinical features of open globe injuries in children.

• METHODS: The medical files of patients under the age of 16 who had been operated for an open globe injury at Akdeniz University Hospital´s Department of Ophthalmology were retrospectively evaluated.

• RESULTS: A total of 90 patients were evaluated in this study. Among these patients, 26 (28.9%) were female and 64 (71.1%) were male. The mean age of the patients was 7.7 ±4.2 years. The male/female ratio was observed to increase with increasing age (P=0.006, r=7.48). Injuries were most likely to occur in spring and autumn (P= 0.028). The time interval between the injury and the surgical repair was 9.36 ±27.4h. Forty (44.4%) of the injuries occurred in the home, 27 (30%) occurred in the yard, and 21 (23.3%) happened while playing in the street. The most common causes of injury were sharp metal objects (P<0.001). Injury to the cornea occurred in 47 (52.2%) of the patients (P<0.001). The most common complication to occur was cataract formation. Additional operations were necessary for 37 (41.1%) of the patients. The final visual acuity was correlated with both the initial visual acuity of the wounded eye prior to surgery and the length of the wound (P<0.001, r=0.502 and P<0.001, r= −0.442, respectively).

• CONCLUSION: Open globe injuries that are suffered in childhood generally occur either at home, in the yard, or on the street, with sharp metal objects being the most common cause of injury. The initial visual acuity and the length of the wound are the most important determinants of the final visual acuity.

• KEYWORDS: childhood; epidemiology; open globe injury; prevention; visual acuity

DOI:10.3980/j.issn.2222-3959.2013.06.20

Ilhan HD, Bilgin AB, Çetinkaya A, Unal M, Yucel I. Epidemiological and clinical features of paediatric open globe injuries in southwestern Turkey. *Int J Ophthalmol* 2013;6(6):855-860

INTRODUCTION

Open globe injuries have been defined as any traumatic full-thickness break in the wall of the eye [1,2]. It is well-established that the leading cause of unilateral vision loss in childhood is trauma to the eye [3-8]. Importantly, disabilities such as vision loss can further lead to longer-term psychological and social problems for the individual; and, due to the longer life expectancies of children, these problems are more pronounced in paediatric cases [9]. It is therefore of the utmost importance that all of the risk and prognostic factors be identified to ensure that the proper preventive measures, treatment, and follow-up are implemented and provided to help minimize the impact of open globe injuries in children.

In an attempt to better understand both the epidemiology and clinical features, as well as the risk and prognostic factors, in open globe injuries in children, we carried out a retrospective study that analyzed the medical files of all patients 16 years of age and younger who had been operated on for an open globe injury at Akdeniz University Hospital in Antalya, Turkey. Antalya is a region of approximately two million people, of which 29% are under the age of 16. It is located in southwestern Turkey on the Mediterranean coast and, with the exception of the mountainous areas, it has a typical Mediterranean climate, with a mild spring and autumn, a hot, dry summer, and a cool, rainy winter. Akdeniz University Hospital is the only referral university hospital located in the city. While there have been several previous reports on open globe injuries from Turkey, this is the first study in Antalya and it also involves a larger number of paediatric patients than the others. Our aim with the present study was to assess the clinical and epidemiological characteristics of paediatric open globe injuries in the Antalya region, as well as to identify both the risk and prognostic factors.

SUBJECTS AND METHODS

This study is a retrospective review of the medical files of paediatric open globe injuries. The medical charts of all children (age ≤16 years) who had been both operated on for open globe injuries and who had received follow-up at

Akdeniz University Hospital's Department of Ophthalmology between January 2000 and June 2012 were evaluated.

All of the globe injuries were classified according to the Birmingham Eye Trauma Terminology (BETT), and the term 'open globe injury' was used to refer to any full-thickness injury to the sclera or cornea of the eye [10]. Patients ≤16 years of age who had been treated for an open globe injury were identified from both operating room and ophthalmology department databases. Furthermore, only those patients that received follow-up regularly for at least 6 months after the primary surgery were included in order to ensure that the final visual acuities that were being assessed were accurate and reliable. Patients with injuries that didn't require any surgery or who had had follow-up periods of less than 6 months were excluded from the study.

The data included the patient's age and sex, the time interval between the injury and surgical repair, and the date, season and place that the injury occurred. The place where the injury occurred was listed as either a rural (countryside or village) or an urban (city) location and as either a closed (home, school) or open environment (yard, street). Additionally, the laterality, location, size, and cause of the wound, and the initial and final visual acuities of the patients were also recorded. Furthermore, it was noted if the patients developed any secondary complications as a result of the injury and whether additional surgeries were required. Finally, the following were also noted during the examination: the condition of the lens and the zone of the injury, any retinal detachment, the presence of a vitreous haemorrhage or hyphema, intraocular foreign bodies (IOFB), endophthalmitis, or sympathetic ophthalmia.

The location of the wound was classified according to the Ocular Trauma Classification (OTC): zone 1, wound limited to the cornea; zone 2, a wound involving the sclera that is no more than 5mm posterior to the limbus; zone 3, a wound that is more than 5mm posterior to the sclera[1]. Also, the location of the wound was classified as either corneal, corneoscleral, or scleral. The visual acuity of the patients was written in decimals in the files and was not converted to another chart for this study. Also, the visual acuity that was measured in the last examination was taken to be the final visual acuity result. Ocular trauma score (OTS) was calculated for each patient and then compared with the final visual acuity.

Patients were divided into two age groups: 0-6 years/ preschool age (Group 1) and 7-16 years/school age (Group 2).

Statistical Analyses All statistical analyses were performed using the SPSS version 18.0 (Chicago, USA) software package. During the comparison of both groups, the t-test was employed in the case of normal and homogenous data, while the Mann Whitney U-test was used where normality and homogeneity assumptions were not fulfilled. The comparison of more than two groups' median values were performed through the use of ANOVA (variance analysis), while the Kruskal-Wallis test was employed where normality and homogeneity assumptions could not be fulfilled. The Chi-square test was used for the comparison of independent variables. The correlation test was performed in order to determine the relationship between two groups. Statistical significance was based on a P-value below 0.05.

This study was approved by the ethics committee of the Akdeniz University Department of Medical Sciences (Reference number: 06.11.2012/278) and it was carried out in strict accordance with the Declaration of Helsinki.

RESULTS

Based on our exclusion criteria, a total of 90 patients, out of a possible 106, were included in this study. Forty-two patients were ≤6 (Group 1) and 48 were >6 (Group 2). The mean age of the patients was 7.7±4.2 (range: 0.5-16 years). Among the patients, 64 (71.1%) were male and 26 (28.9%) were female. The male:female ratio was 4:3 in Group 1 and 5:1 in Group 2. The male:female ratio was observed to increase as the age of the patients increased (P=0.006, r=7.48).

The mean length of time for the interval between the occurrence of the injury and the surgery was 9.36±27.4h. The time interval between the trauma and surgery was found to be significantly longer in patients from rural areas compared to patients from urban areas (14.3 ±37.3h *vs* 4.2 ±6.5h, respectively). No statistically significant difference was observed between Group 1 and Group 2 in terms of the length of time between injury and surgery.

As for the place of the accident, forty (44.4%) of the injuries occurred in the home, while 27 (30%) occurred in the yard, and 21 (23.3%) happened while playing in the street. One patient in Group 2 was injured at school (1.11%) and the place of injury was unknown for one patient in Group 1. In Group 1, the injury occurred in closed spaces (such as the home) in 59.5% (P<0.001) of cases while in Group 2 the injury occurred in open spaces (street and yard) in 66.7% of the cases (P=0.021) (Figure 1).

In terms of a seasonal distribution for the occurrence of the injuries, significantly more injuries occurred in the autumn (34; 37.8%) and the spring (23; 25.6%) than in the summer (17; 18.8%) and the winter (16; 17.8%)(P<0.05) (Figure 2).

While a variety of objects were found to have caused the injuries, metal objects were the most common source of injury in both groups [Group 1: 25 patients (59.5%) (P< 0.001), Group 2: 19 patients (39.6%) (P=0.058)]. Pieces of wood, glass, stone and plastic were also responsible for causing some of the injuries. In one case, the object that caused the trauma was unknown (Figure 3).

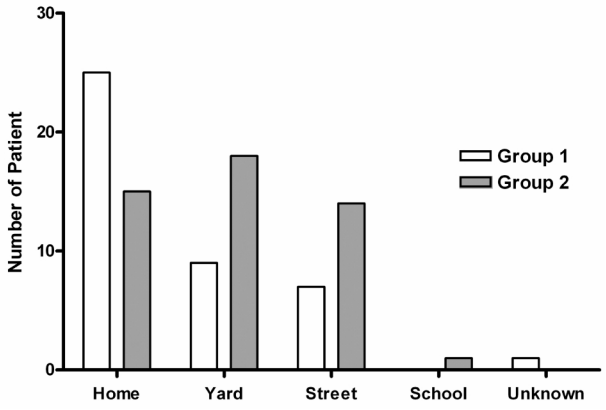

Figure 1 Distribution of the patients according to the place of the accident.

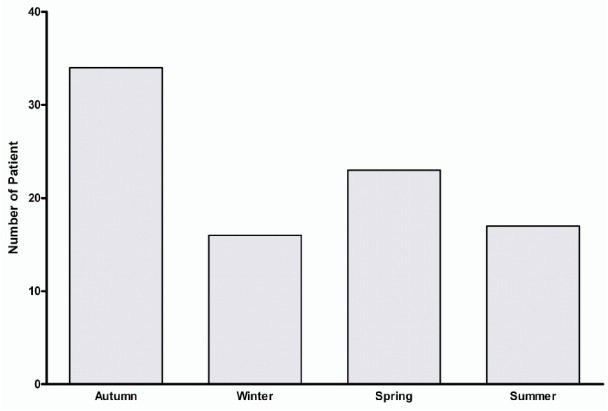

Figure 2 Distribution of the patients according to the seasons.

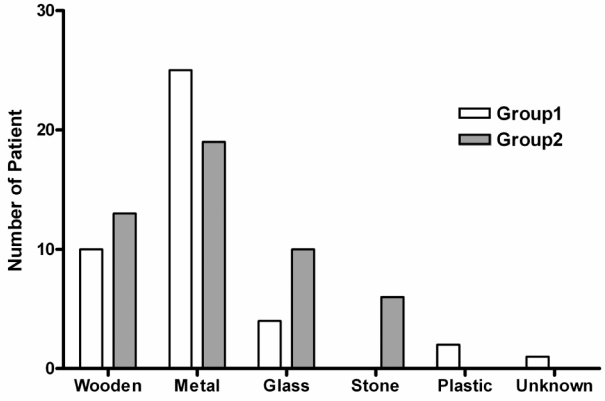

Figure 3 Distribution of the patients according to the object that caused the trauma. This distribution was found to be statistically significant (P<0.001).

Among both groups, the injury occurred in the right eye of 55 patients (61.11%) and the left eye of 35 patients (38.89%). In Group 1, the right:left eye injury ratio was 28:14. The ratio of the injuries to the right eye was found to be significantly higher in Group 1 (P=0.031). In Group 2, the right:left eye injury ratio was 27:21 and, although injuries to the right eye were more frequent, this difference was not found to be statistically significant (P=0.317).

The location of the injury was corneal in 47 patients (52.2%), scleral in 17 patients (18.9%) and corneoscleral in 26 patients (28.9%) (P <0.001) (Table 1). Additionally, when the injuries were assessed in terms of the zone, the percentages

Table 1 Distribution of the affected eye and the injury zone according to the groups *n* (%)

Parameters	Group 1	Group 2
Injured eye (right/left)	28(66.7)/14(33.3)	27 (56.3)/21(43.7)
Corneal	26 (61.9)	21 (43.8)
Corneoscleral	10 (23.8)	16 (33.3)
Scleral	6 (14.3)	11 (22.9)

Table 2 The initial and final visual acuity of the patients *n* (%)

Visual acuity	Initial	Final
≥0.5	2 (2.2)	30 (33.3)
0.1-0.4	6 (6.7)	16 (17.8)
≤0.05	49 (54.4)	30 (33.3)
Unspecified	33 (36.7)	14 (15.6)[1]
Total	90 (100)	90 (100)

[1]In the medical charts of these 14 patients no final visual acuity was recorded.

were also similar. The final visual acuity was not found to be correlated with the location of the injury. The mean wound length was 6.98±3.89mm (with a minimum of 0.5mm and a maximum of 18mm) and was correlated with the final visual acuity (r=-0.442, P<0.001). Of the 30 patients with a final visual acuity of ≤0.05, only 5 had a wound length of ≤5mm.

The mean duration of the post-injury follow-up period was 19.31±23.46 months (20.28±22.8 in Group 1 and 18.46±24.23 months in Group 2). In 33 patients the visual acuity in the injured eye could not be evaluated at the initial presentation and in 14 patients the final visual acuity could not be evaluated. Among the 76 patients in which the final visual acuity could be evaluated, 30 patients had a visual acuity of 0.5 or higher (47.4%) and 30 patients (39.5%) had a final visual acuity below 0.1 (Table 2). There was no statistically significant difference between the final visual acuity and either age or the time interval between the trauma and surgery. The final visual acuity was, however, found to be correlated with the visual acuity in the injured eye at the initial assessment. (P <0.001, r =0.502). In our study, the OTS was not found to be statistically correlated to the final visual acuity (P=0.243, r=0.159).

The most common complication that accompanied the open globe injuries was cataract, which developed in 39 of the patients, of which 15 (35.7%) were in Group 1 and 24 (50.0%) were in Group 2. Hyphema was observed in 21 patients and an intravitreal haemorrhage was observed in 3 patients. Among the patients, 47 (52.2%) had iris prolapse, while 7 (7.8%) had choroid prolapse. Iridodialysis was detected in 12 patients (13.3%). In 5 patients the presence of IOFB was detected. The effects of these conditions on the final visual acuity, however, were not found to be statistically significant. Fifteen patients (17%) had retinal detachment, and in one patient it led to phthisis. Additionally, strabismus (2 patients), endophthalmitis (1 patient), total leucoma (1 patient) and glaucoma (1 patient) were also observed. A total

of 37 patients (41.1%) required additional surgery.

DISCUSSION

Previous studies have reported that the sex of the patient is an important factor in eye injuries to children which occur through cutting and piercing, with young males more likely to suffer such injuries than girls [11-13]. And, indeed, open globe injuries are more frequently observed in males than in females [3,4,8,14-20]. This trend has been attributed to the dangerous and risky activities that boys are more inclined to participate in than girls [1,2]. Similar to previous studies, our study also found that males suffered the majority of open globe injuries, with the male:female ratio being observed to increase with increasing age. Among all of the patients included in this study, the male:female ratio was 5:2, while among the older children it was 5:1. In the ≤6 age group, however, it was significantly lower (4:3). The relatively lower ratio of males: females found among the younger ages has been explained by the fact that at younger ages both boys and girls engage in similar daily activities[14,21].

Prior studies have shown that injuries most frequently occur at home or on the street [13-16,22]. In our study, based on the cases where the place of the injury was known, the majority of the injuries were found to have occurred at home (44.4%), followed by the yard (30%) and the street (23.3%) ($P<0.05$). When the place of injury was assessed as either indoors (home, school) or outdoors (yard, street), it was observed that the majority of the injuries had occurred outdoors (53.9%), although the difference was not statistically significant. It has also been reported that the place where the injury occurs varies according to age [13-16,22]. Indeed, in our study, the most common place of injury in the ≤6 age group was the home, whereas it was the yard and street in the 7-16 age group ($P<0.05$). This difference is probably because younger children generally spend more time at home than do older children; older children, on the other hand, are more likely to be outside engaging in unsupervised activities. In only one child did the injury occur at school. It should be noted that all of the patients included in this study were injured accidentally.

Numerous studies have reported sharp tools, such as scissors or knives, as the most common source of injury to the eye among children[23-25]. This can, however, vary, as two previous studies carried out in Turkey demonstrate: while Tok *et al* [18] also reported that metal objects were most likely to be responsible for eye injuries, Cetin *et al* [16] found that pieces of wood accounted for the largest percentage of injuries, at 29.7%. In our study, metal objects were the source of 48.9% of the injuries, while 25.6% were due to objects made of wood, such as sticks, twigs or small wooden fragments. The injuries incurred due to metal objects were mainly caused by scissors, knives, wires, teapots, metal lids, needles or nails. Also, 6.7% of the injuries were sustained by gunshot or explosives, with pellets, bullets or metal fragments of firecrackers being the objects causing the trauma. Between Group 1 and Group 2 there were differences in terms of the object causing injury: while metal objects, such as knives or scissors, were responsible for 59.5% of the injuries in Group 1, this number was even higher in Group 2, with 39.6% of the injuries being caused by metal objects; this difference, however, was not statistically significant. While objects such as knives and scissors are to be found in virtually every household, it is important that these implements be kept out of the reach of children, and only used, when necessary, under adult supervision.

In younger children, information about the circumstances of the injury could sometimes not be obtained from the family because nobody was there to witness the accident. In the literature, the cause of injury is generally unknown in 2.0%-13.4% of cases[3,18,23-25]. In our study, this percentage was lower (1.1%), with just a single 3-year old patient from a rural area in which the injury wasn't immediately noticed.

The results of our study also point to a seasonal difference among the injuries. The majority of the injuries occurred in the autumn (37.8%), followed by the spring (25.6%), summer (18.8%), and winter (17.8%). Other studies conducted in different regions of Turkey have reported that injuries most commonly occur during the summer months [24,26]. The difference between these studies and ours is that they occurred in regions of Turkey where people are more likely to be outside and active during the summer months. Podbielski *et al* [27] observed in Canada that globe injuries most frequently occurred during the summer, while the fewest injuries occurred in the winter. Another study from Kuwait reported that the frequency of injuries reached their peak in October and lowest levels in June[28]. Of course, these seasonal differences may result from the climatic characteristics and the lifestyle of the people in the region where the study was conducted. In Antalya, where our study was conducted, the spring and autumn are mild and warm and children generally spend a lot of time playing outside on the street and in the yard, while the summer is very hot and not much time is spent outdoors. The fact that the fewest injuries occur in the winter may be explained by the fact that the days are shorter, children are in school and busy with homework, and the weather can often be cold and rainy.

Similar to previous studies, we also found that the majority of the injuries (52%) were corneal (zone 1)[14,16,18,19,22-24,29,30].

No statistically significant difference was observed in terms of the affected eye [16,23]. The majority of accidentally self-inflicted injuries in the literature involve the right eye, although the difference hasn't been found to be statistically significant[14]. In our study, however, a statistically significant difference in favour of right eye injuries (66.6%) was found

among the patients in Group 1 (≤ 6 years) but not among the patients in Group 2. This difference may be explained by the fact that younger children use tools, such as scissors and knives, with their dominant hands when their manual skills are still developing.

It is important to note that with eye injuries involving children, it is not always possible under emergency conditions to properly assess the condition of the eye and to be able to measure the initial visual acuity; and this, of course, is a limiting factor in making a prognosis [3,4,25]. In our study, the baseline visual acuity at the initial presentation could not be evaluated in 37.8% of the patients. Among the patients in which the visual acuity could be measured, 39.5% had a final visual acuity of 0.5 or above. In previous studies, the percentage of patients in which the final visual acuity reached 0.5 or above has been reported to be between 29%-54%[14-16,18,22-25,30,31]. Furthermore, the reported percentages of patients in which the visual acuity remained below 0.1 has ranged between 21% and 58%[14,16,18,19]. In our study, the final visual acuity was found to be below 0.1 in one out of every three patients.

A number of previous studies have attempted to identify the factors which can affect the final visual acuity. Those that have been proposed include age, the time interval from injury until initial presentation, the size of the wound, the initial post-injury visual acuity, injury to the posterior segment, the presence of IOFB, endophthalmitis, the emergence of additional complications, and the location of the trauma in the eye[4,12,15,16,25,30-33]. In this study, we have found that there is a positive correlation between the initial and final visual acuities. We also found that the final visual acuity is negatively correlated with the length of the wound. Furthermore, in those cases in which there was either a zone 1 injury or where the wound was long enough to cover the pupil, there was a lower final visual acuity, especially when the wound length was longer than 5mm. This result is similar to some reports in the literature in which a wound length of more than 6mm is listed as one of the risk factors that can lead to a lower final visual acuity [32]. Furthermore, while hyphema and cataract may lead to a reduced visual acuity, it is also possible that an inaccurate examination may report the visual acuity to be either falsely low or high.

Despite the fact that the OTS has been shown to be an important predictor of paediatric age, we didn't find any statistical correlation between the OTS and the final visual acuity[16,17,32]. Of course, we only calculated an OTS for the 57 (63.3%) patients included in this study for which an initial visual acuity had been recorded. Additionally, the relative afferent pupil defect sometimes couldn't be checked. Sometimes the records wrote with less information. Due to the children and their family's panic, full examination could be wasting time. And the patients were prepared to the operations as fast as possible. In some cases, a full examination was conducted while the patient was under general anaesthesia. Anatomical data, including wound measurement, localisation of the wound should be pointed out in calculating a score for paediatric patients.

It is well established that open globe injuries in children often necessitate multiple surgeries [14,16,18,19,23,24]. In our study, 41.1% of the patients required multiple surgeries. This is a significant problem, as injuries suffered in childhood that require repeated surgical interventions and examinations not only can cause functional loss, but can also lead to psychosocial problems[34].

This study has several limitations. The first is the fact that it is retrospective and non-randomised in nature. Furthermore, the data was limited to what was provided in the patients' medical records. Finally, the study probably slightly underreports the actual incidence of paediatric open globe injuries in the Antalya region because only injuries treated at the university hospital were included.

It is important to consider the challenges that sometimes face emergency room personnel when dealing with a paediatric trauma patient who may not be calm enough to permit a thorough examination. While it should always be a priority of the ophthalmologist to get an accurate measurement of the initial visual acuity, in instances where this isn't possible, the patient should be operated on as soon as possible.

In conclusion, we found that the initial visual acuity is the most important predictor of the final visual acuity. Furthermore, the length of the wound was also found to be related to the final visual acuity. Additionally, one third of the open globe injuries in this study resulted in the functional loss of eyesight in the injured eye. It is therefore important that children and families be better educated about eye safety and warned of the potential consequences of an injury. While it seems reasonable to believe that the results of this study are widely applicable, a large, multi-centered study spanning across different climactic regions is necessary to fully understand the epidemiology of open globe injuries on a global scale.

Acknowledgements: The authors are grateful to the biologist Sezgi Seref Gun, PhD for help with the statistical analyses.

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