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ORIGINAL ARTICLE

Open Globe Injury in a Tertiary Hospital in Northern Taiwan: A 10-year Review

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Background: Major ocular trauma is an injury with potential blindness in ophthalmology. The aim of this study was to evaluate the demographic and etiologic factors of major ocular trauma in a tertiary hospital in Northern Taiwan. **Subjects and Methods:** A retrospective review of patients who suffered from open globe injuries and underwent management in a tertiary hospital between January 1, 2005, and December 31, 2014, was conducted. Patients with prior ocular trauma, preexisting ocular conditions affecting the visual acuity (VA) and those with a history of previous intraocular or refractive surgery was excluded from this study. **Results:** Totally 199 eyes of 195 patients were enrolled in this study. Open globe injury occurred more frequently in males than in females (136 vs. 63 patients, $P < 0.0001$). Workplace is the most common place of injury (56.3%), followed by home (23.1%). Among patients younger than 18-year-old, domestic-related injury was the predominant cause (78.6%), while among those aged above 18 years, occupational injuries were the most common cause (62.0%). Compared with VA measured on admission, final VA was improved in 38.6%, unchanged in 48%, and worse in 13.4%. The visual outcome was found to be significantly associated with the initial VA, posterior extent injury, length of wound, and presence of vitreous prolapse. **Conclusions:** Unfavorable prognostic factors for final visual outcome in these patients are related to initial VA, posterior extent injury, length of wound, and presence of vitreous prolapse. Results of this study help predict visual outcomes of open globe-injured patients in emergent counseling.

Key words: Ocular trauma, open globe injury, penetrating eye injury

INTRODUCTION

Ocular trauma is an injury with potential blindness, and it often causes significant visual loss despite prompt management. Ocular trauma accounts for 65% of noncongenital unilateral blindness in the United States.[1] Compared with closed globe injuries; open-globe injuries usually result in significant worse visual outcomes in ocular trauma.[2] The previous studies have shown different visual outcomes in child and adult patients with either closed or open globe injuries. Factors such as initial visual acuity (VA), type of injury, location and extent of the wound, severity of vitreous hemorrhage, and type of intraocular foreign body (IOFB) showed correlation with the final visual outcome.[3,4] Among pediatric eye injuries in Taiwan, the majority (91%) were laceration wounds of the ocular adnexa, and 76.1% of patients got improved visual outcomes.[5] Moreover, most of these injuries are preventable, especially in children who often got injuries at home from play or sports activities. On the contrary, adults who suffered mainly from occupational injuries resulting in open globe injury had a worse outcome.[1]

The epidemiology of ocular trauma varies with time and region, and ocular trauma may have a higher incidence, larger trauma extent, and poorer outcome in the developing countries.[6] Taiwan as a developing country in Asia only has ocular trauma data in pediatric patients reported.[5,7] There are limited data regarding the visual outcomes after open globe injuries in Northern Taiwan. Herein, we report our experience with treating open globe injuries and determine the prognostic factors of visual outcome.

SUBJECTS AND METHODS

A retrospective chart review of all patients with open globe injury that presented to Tri-Service General Hospital, Taipei,

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Taiwan between January 1, 2005, and December 31, 2014, was conducted. The study protocol and supporting documents were reviewed and approved by the institutional review board of the Tri-Service General Hospital, Taipei, Taiwan (2-104-05-019). The study followed the Good Clinical Practice Guidelines of Taiwan and was in accordance with the Declaration of Helsinki, 1964, and later revisions.

Classification of open globe injury in this study was made according to the Birmingham Eye Trauma Terminology.[8] The term "open globe injury" denotes full-thickness wound of the eyewall and includes rupture of the eyeball, penetrating eye injury, IOFB, and perforating eye injury.

Records of all patients diagnosed with open globe injury were obtained. Patients with a history of prior ocular trauma, preexisting ocular conditions affecting the VA, and previous intraocular or refractive surgery were excluded from this study.

VA was measured at a distance of 6 m using the E-chart for school-aged children and adults. For preschool children, VA was assessed with the fixation and follow test patterns.

Demographic details, date of injury, type and extent of injury, cause of injury, details of initial and subsequent treatments, operations performed, complications encountered, initial VA, and final visual outcome (defined as VA at least 3 months after injury) were recorded for each patient from charts.

Student's *t*-test was employed to evaluate the significance of differences in patient age by gender, and the Chi-square test was utilized to evaluate the significance of differences in patient gender by age and differences in final VA by type of injury. Parameters affecting the final visual outcome were recorded and assessed; and they included type of injury, initial VA, posterior extent injury, length of wound, lens injury, hyphema, and presence of vitreous prolapse. Associations between these categorical parameters and the final visual outcome (VA <10/200, ≥10/200 to <20/40 and ≥20/40) were examined with multinomial logistic regression analysis. The level of statistical significance was set at a $P < 0.05$.

RESULTS

Totally, there were 222 eyes of 218 patients with open globe injuries who underwent management during the abovementioned period. Of them, 23 eyes were excluded due to incomplete medical records or loss of follow-up. Follow-up periods varied from 3 months to 5.5 years, with a mean of 13.9 months. Of the 195 patients enrolled (199 eyes), 134 (136 eyes) were males (68.3%) and 61 (63 eyes) were females (31.7%). The age of patients ranged from 4 to 93 years, with a mean age of 44.5 years (standard deviation = 22.14). Table 1 summarizes the demographics of patients studied. Among the injured eyes, 89 eyes were right eyes (44.7%) and 110 were left ones (55.3%). There were two patients having bilateral injuries. Details of visual acuities are also shown in Table 1. Most eyes (73.9%) had an initial VA worse than 10/200, and final VA of 20/40 or better was observed in 27.6% of injured eyes.

Table 2 lists the causes of injuries. As can be seen, workplace was the most common site where injury occurred (n = 112, 56.3%), followed by home (n = 46, 23.1%). Occupational injuries (n = 102, 51.3%) and indoor accidents (n = 72, 36.2%) accounted for most of the open globe injuries. There were 124 open globe injuries resulting from blunt trauma (62.3%) while injuries from sharp objects were much less (n = 70, 35.2%). Details regarding injury types were also analyzed, revealing blunt injuries from metal objects (n = 68, 34.2%)

Table 1: Patient demographics

Variables	n=199 (%)
Gender	
Male	136 (68.3)
Female	63 (31.7)
Age (years)	
0-<6	2 (1.0)
6-<12	5 (2.5)
12-<18	9 (4.5)
18 years and older	183 (92.0)
Injury laterality	
Right eye	89 (44.7)
Left eye	110 (55.3)
Initial visual acuity	
NLP	51 (25.6)
LP	34 (17.1)
HM	18 (9.0)
CF	25 (12.6)
Better than CF to<10/200	19 (9.5)
10/200-<20/40	32 (16.1)
20/40-20/20	20 (10.1)
Final visual acuity	
NLP	96 (48.2)
LP	12 (6.0)
HM	5 (2.5)
CF	2 (1.0)
Better than CF to<10/200	13 (6.5)
10/200-<20/40	16 (8.0)
20/40-20/20	55 (27.6)

NLP = No light perception; LP = Light perception; HM = Hand movement; CF = Counting fingers

and falls (n = 37, 18.6%) as the two most common causes of open globe injuries. As for causes resulting in sharp injuries, the most common one was tools during occupational activities or indoor events (n = 34, 17.1%). Poking by sticks was the second common cause that induced sharp injuries, and not limited to children (n = 10, 5%).

Table 3 summarizes information regarding type, length, extent, existence of hyphema, and intraocular tissue involvement of open globe injuries. Nearly half of the patients' wounds were restricted within the cornea (n = 87, 43.7%) while 39.2% of patients had their wounds before rectus muscle

Table 2: Open globe injury related circumstances

Variables	n=199 (%)
Site of injury	
Workplace	112 (56.3)
Home	46 (23.1)
Street/park/playground	26 (13.1)
School	5 (2.5)
Others	3 (1.5)
Not documented	7 (3.5)
Causes of injury	
Occupational injury	102 (51.3)
Domestic-related	72 (36.2)
Sport trauma	14 (7.0)
Motor vehicle accident	5 (2.5)
Others	3 (1.5)
Not documented	3 (1.5)
Mechanism of injury	
Blunt	124 (62.3)
Sharp	70 (35.2)
Burn	2 (1.0)
Not documented	3 (1.5)
Objects causing injury	
Blunt objects	
Metal	68 (34.2)
Fall	37 (18.6)
Balls	9 (4.5)
Hand/fist	5 (2.5)
Stone	3 (1.5)
Traffic accident	2 (1.0)
Sharp objects	
Tool	34 (17.1)
Sticks	10 (5.0)
Glasses/spectacles	9 (4.5)
Toys	8 (4.0)
Pencils/pens	3 (1.5)
Scissors	2 (1.0)
Wire	2 (1.0)
Finger nails	2 (1.0)
Burn injury	
Fireworks	2 (1.0)
Unknown	3 (1.5)

Table 3: Clinical data related to open globe injuries

Variables	n=199 (%)
Extension of wound posteriorly	
Restricted to the cornea	87 (43.7)
Anterior to rectus muscle insertion	78 (39.2)
Anterior to equator	25 (12.6)
Posterior to equator	9 (4.5)
Length of the wound (mm)	
1-4	54 (27.1)
5-8	91 (45.7)
9-12	30 (15.1)
more than 12	24 (12.1)
Hyphema (%)	
None	23 (11.6)
Hyphema <50	131 (65.8)
Hyphema >50	45 (22.6)
Involvement of intraocular structures	
None	21 (10.6)
Uveal tissue prolapse only	76 (38.2)
Lens involvement only	24 (12.1)
Vitreous prolapse only	4 (2.0)
Involvement of >2 structures noted above	95 (47.7)
Surgical management	
Primary closure of eye wall wound alone	119 (59.8)
Primary closure of eye wall wound combined with anterior segment surgery only	38 (19.1)
Primary closure of eye wall wound combined with posterior segment surgery	10 (5.0)
Evisceration	32 (16.1)
Total	199
Complications	
Anterior segment complications[a]	132 (52.0)
Lens-related complications	31 (12.2)
Posterior-segment complications[b]	83 (32.7)
Phtisis bulbi	8 (3.1)
Sympathetic opthalmia	0 (0.0)

[a]Corneal scar, iris damage, secondary glaucoma, [b]Vitreous hemorrhage, retinal detachment, optic neuropathy

insertion (n = 78). The majority of wounds were 5–8 mm in length (n = 91, 45.7%). At their presentation, 88.4% (n = 176) of patients had hyphema by slit-lamp microbioscopy; and among them, 74.4% (n = 131) had only mild or < 50% of anterior chamber of hyphema. All the patients underwent emergent operations to repair their globe laceration and/or evisceration. Evisceration was performed over 32 eyes (16.1%) in the first setting to prevent sympathetic ophthalmia. For those who did not receive evisceration at emergent operation, 119 eyes (59.8%) needed only primary corneal wound closure. Complications of anterior chamber, such as corneal scar, iris damage, secondary glaucoma, occurred in 52% of surgical eyes (n = 132). The second most common complication after surgery was posterior chamber complication (n = 83, 32.7%) while vitreous hemorrhage was the most common cause for these complications.

To understand the prognostic factors related to visual outcome, several variables were analyzed and those with $P < 0.05$ would be regarded as prognostic factors. Variables such as initial VA, posterior extent injury, length of wound, and presence of vitreous prolapse were found to be highly associated with poor visual outcome, but not anterior segment involvement, lens involvement, iris/uvea prolapse, or hyphema [Table 4].

Patient data were analyzed to shed light on the frequency of open globe injuries during different time settings. It was found that open globe injuries happened more often in winter and less in autumn though the difference is not significant [Figure 1]. However, in the week setting, the frequency of open globe injury was highest on Monday ($P < 0.05$) and Friday ($P < 0.05$) and lowest at the weekend ($P < 0.05$).

Table 4: Factors affecting visual outcome

Prognostic factors	Final VA			P
	≧20/40	10/200-<20/40	<10/200	
Initial VA				
<10/200	21	4	122	<0.001
10/200-<20/40	16	11	5	
≧20/40	18	1	1	
Extent of injury				
Anterior segment only	49	11	27	0.277
Posterior segment involved	6	5	101	0.004
Length of wound (mm)				
1-4	51	2	1	<0.001
5-8	4	12	75	
9-12	0	1	29	
>12	0	1	23	
Lens involvement				
Yes	18	10	89	0.354
No	37	6	39	
Iris/uvea prolapse				
Yes	12	4	86	0.107
No	43	12	42	
Vitreous porlapse				
Yes	6	1	79	0.001
No	49	15	49	
Hyphema				
Yes	30	9	128	0.241
No	25	7	0	

VA = Visual acuity

DISCUSSION

Ocular trauma is an injury with potential blindness, and it often results in the significant visual loss despite prompt management. However, most of the injuries are preventable.[7] This study enrolled patients having open globe injury during the past decade in a tertiary medical center in Northern Taiwan. Detailed demographic analysis and identification of prognostic factors are helpful for primary ophthalmologists in primary prevention and further management. In this study, the male-to-female ratio is 2.16:1, which is close to but less than that in previous studies.[7,9,10] Age at time of injury peaks at ages between 20 and 60 years, which coincide with that of patients who suffered trauma at workplaces. The most common injury type is blunt ocular injuries (62.3%), and blunt impact from metal substances (34.2%) is the most common cause of these injuries. Wearing helmet or goggles during working is an easy and efficient way to prevent these injuries with potential blindness.

Unlike children with open globe injuries having favorable visual outcomes, adults faced a more disappointing outcome. In this study, there were significantly more patients aged above 20 years with a blind visual outcome (no light perception) than patients below 20 years old (95/180, 53% vs. 1/19, 5.3%). The difference is mainly due to difference in injury type between these two groups. Children in this study were mostly injured at home or playground by plastic airsoft pellets, fireworks, pencil tips, or sports injury. In these incidences, children often suffered minor ocular injury and were transferred to the hospital within a short time. They usually presented with better initial vision acuity (26.3% of patients' VA better than 20/40), and that often led to a better visual outcome. In contrast, adults aged above 70 years often ended up with a poor outcome. Most of them (20/21, 95%) presented with initial VA worse than 10/200, and only 9.5% (2/21) had their VA improved after management. In addition, the main cause of open globe injury in old patients is falls at home or nursing facility, which is often preventable.

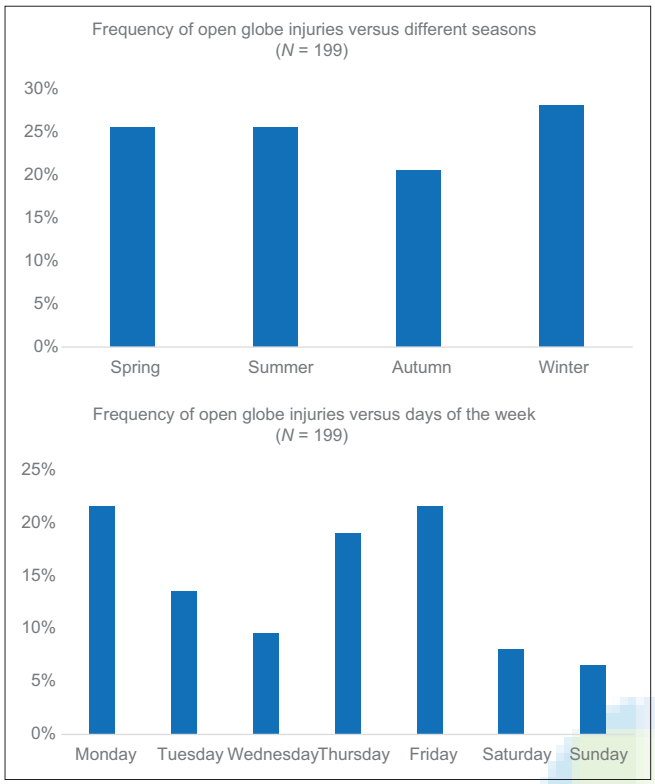

Figure 1: Frequency of open globe injuries in different seasons and days of the week

The ocular trauma classification group suggests four prognostic factors at initial evaluation of ocular injuries: (1) type of injury, (2) initial VA, (3) the presence or absence of a relative afferent papillary defect (RAPD), and (4) location of injury describing the nature and extent of the injury.[11] However, some factors, such as RAPD, cannot be easily assessed at primary evaluation. In specific conditions, children patients may need detailed evaluation under general anesthesia. Some studies suggested that primary ophthalmologists should evaluate the children group even without initial VA and RAPD sign.[7] This study enrolled patients of ages ranging from 4 to 93 years and identified four unfavorable prognostic factors for final visual outcome in these patients, namely, initial VA, posterior extent injury, length of wound, and presence of vitreous prolapse. Although all these factors could be identified at primary evaluation in adults, children who could cooperate in measuring VA in this study usually had better VA outcome.

There is a debate on whether hyphema is a visual prognostic factor. Some studies suggest that patients presented without hyphema are twice less likely to have final VA worse than 10/200 as compared with those with hyphema.[12] However, some studies have contrary results.[13,14] This study did not find any relationship between hyphema and final visual outcome. Instead, vitreous prolapse presents a strong prognostic factor to visual outcome in this study, which echoes previous findings.[12,15] Prior research reported that patients who had vitreous prolapse were twice likely to have final visual outcome <10/200.[15]

Analysis on injury time was made to see if there is a potential risk at specific day of the week or season of the year. Open globe injuries were found to occur more commonly on Mondays, Thursday, and Fridays, and less often during weekends. There was no specific trend among different seasons [Figure 1]. These results were different with previous findings. Studies specific on children ocular injuries revealed the highest incidence on Mondays.[16,17] However, studies including adults and children showed their highest incidence on Mondays and weekends.[18] These discrepancies can be attributed to differences in area and culture of the enrolled patients among the studies. In this study, patients were most commonly injured at workplace during the first and last two work days and less often injured at weekends. The same trends found among pediatric patients of this study could be accounted for by an increase in unsupervised activity on Mondays but not on weekends.

This study had two limitations. First, there was insufficient documentation about initial ophthalmic evaluation at ER spot. This may be related to facilities limitation at ER. Some of the initial evaluation findings were obtained from operative notes. Second, this study only revealed status of open globe injuries in Northern Taiwan where most medical facilities are located. The current results may not reflect the actual status in other parts of Taiwan.

CONCLUSION

The most common causes of open globe injuries are occupational injuries and domestic accidents. Predictors of good visual outcome are initial VA, posterior extent injury, length of wound, and presence of vitreous prolapse. Better understanding of prognostic factors may help primary ophthalmologists provide patients with realistic estimations of the final visual outcome. As seen in this study, most open globe injuries are preventable, thus suggesting the need to educate the public about safety facilities not only at work but at home. Moreover, guidelines on occupational safety and health should also be established to reduce eye injuries.

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Conflicts of interest

There are no conflicts of interest.

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