·Clinical Research·

Open globe injury in Hospital Universiti Sains Malaysia – a 10-year review

Madhusudhan A/L Paramananda [1,2], *Evelyn-Tai Li Min* [1,2], *Zamri Noordin* [1,2], *Adil Hussein* [1,2], *Wan-Hazabbah Wan Hitam* [1,2]

[1]Department of Ophthalmology, School of Medical Sciences, Health Campus, Universiti Sains Malaysia, Kubang Kerian, Kelantan 16150, Malaysia
[2]Hospital Universiti Sains Malaysia, Kubang Kerian, Kelantan 16150, Malaysia
Correspondence to: Wan-Hazabbah Wan Hitam. Department of Ophthalmology, School of Medical Sciences, Health Campus, Universiti Sains Malaysia, Kubang Kerian, Kelantan 16150, Malaysia. hazabbah@kb.usm.my
Received: 2013-07-15 Accepted: 2014-01-13

Abstract

• **AIM: To identify the aetiology of open globe injuries at Hospital Universiti Sains Malaysia over a period of 10y and the prognostic factors for visual outcome.**

• **METHODS: Retrospective review of medical records of open globe injury cases that presented from January 2000 to December 2009. Classification of open globe injury was based on the Birmingham Eye Trauma Terminology (BETT). Records were obtained with hospital permission *via* the in-house electronic patient management system, and the case notes of all patients with a diagnosis of open globe injury were scrutinised. Patients with prior ocular trauma, pre-existing ocular conditions affecting the visual acuity, contrast sensitivity, central vision or corneal thickness, as well as those with a history of previous intraocular or refractive surgery were excluded. Analysis of data was with SPSS version 20.0. Ordinal logistic regression analysis was used to examine the association between prognostic factors and visual outcome.**

• **RESULTS: This study involved 220 patients (n=222 eyes). The most common place of injury was the home (51.8%), followed by the workplace (23.4%). Among children aged less than 16y of age, domestic-related injury was the predominant cause (54.6%), while in those aged 16y and above, occupational injuries were the most common cause (40.0%). Most eyes (76.5%) had an initial visual acuity worse than 3/60, and in half of these, the visual acuity improved. The visual outcome was found to be significantly associated with the initial visual acuity (P<0.005), posterior extent of wound (P<0.001), length of wound (P<0.001), presence of hyphaema (P<0.001) and presence of vitreous prolapse (P<0.005).**

• **CONCLUSION: The most common causes of open globe injury are domestic accidents and occupational injuries. Significant prognostic factors for final visual outcome in patients with open globe injury are initial visual acuity, posterior extent and length of wound, presence of hyphaema and presence of vitreous prolapse. Awareness of the factors predicting a poor visual outcome may be helpful during counselling of patients with open globe injuries.**

• **KEYWORDS:** eye injuries; occupational injuries; vision disability; visual impairment; accidents; intraocular foreign body

DOI:10.3980/j.issn.2222-3959.2014.03.18

Madhusudhan P, Evelyn-Tai LM, Zamri N, Adil H, Wan-Hazabbah WH. Open globe injury in Hospital Universiti Sains Malaysia – a 10-year review. *Int J Ophthalmol* 2014;7(3):486-490

INTRODUCTION

Ocular trauma is a prominent cause of visual disability, contributing up to 65% of cases of unilateral blindness worldwide, depending on the sample population [1-5]. The burden of blindness is related not only to its inevitable effect on quality of life, but also to the loss of productivity associated with the remaining blind person-years [6]. In most studies, the largest groups affected are children or young adults, resulting in even greater socioeconomic implications of this condition[7-10].

The epidemiology of ocular trauma is a subject of interest worldwide [3,7,11,12]. The proportion of open versus closed globe injury varies in different studies [13-17]. However, it is generally accepted that open globe injury results in more hospitalisation and a poorer visual outcome than closed globe injury [7,11,18-21]. Among paediatric eye injury-related hospitalisations in the United States, the majority were for open wounds of the ocular adnexa, and likewise in those hospitalised for work-related ocular injury [18,22]. Unlike in adults, where occupational injuries predominate, most trauma resulting in open globe injury in children occurs at home[3,21]. Regrettably, a significant number of these injuries are preventable, especially in children[17,21,23-26].

Despite the significant visual disability related to open globe injuries, the circumstances in which they occur have not been thoroughly elucidated, nor the clinical features predicting a worse visual outcome. The aim of this study was to determine the aetiology of open globe injuries in our population and the prognostic factors associated with visual outcome.

SUBJECTS AND METHODS

We conducted a retrospective case review of all patients with open globe injury that presented to Department of Ophthalmology, Hospital Universiti Sains Malaysia, over a period of 10y. Methods complied with the tenets outlined in the Declaration of Helsinki. Our classification of open globe injury was based on the Birmingham Eye Trauma Terminology [27,28]. Records were obtained with hospital permission *via* the in-house electronic patient management system, and the case notes of all patients with a diagnosis of open globe injury were scrutinised. Patients with prior ocular trauma, pre-existing ocular conditions affecting the visual acuity, contrast sensitivity, central vision or corneal thickness, as well as those with a history of previous intraocular or refractive surgery were excluded. Analysis of data was with SPSS version 20.0. Ordinal logistic regression analysis was used to examine the association between prognostic factors and visual outcome.

RESULTS

From 2000 to 2009, 220 patients (n=222 eyes) with open globe injury were admitted to Hospital Universiti Sains Malaysia, Kelantan, Malaysia. Approximately 4/5 of them were male (Table 1). All patients were Asian, and more than 90% of cases were of Malay ethnicity. Their ages ranged from 1 to 79 years old, with the mean and median age being 22 and 19 years old respectively. Seventy percent of cases occurred in those aged less than 30 years old, with the majority of open globe injuries (33%) occurring in the first decade (Table 2). Two patients had bilateral open globe injuries, while in the remainder, the distribution of cases showed no predilection for involvement of either eye.

The most common place of injury was the home (51.8%), followed by the workplace (23.4%) and the street (18.5%). Besides domestic-related open globe injury, which was the significant type of injury (37.4%), other types included occupational injuries (23.4%), motor vehicle accidents (17.6%), and animal-related injuries (12.6%).

Among children aged less than 16y of age, domestic-related injury was the predominant cause of open globe injury (54.6%), followed by animal/agriculture-related injuries (23.7%). This differs in the group aged 16y and older, where occupational injuries were the most common cause (40.0%), followed by motor vehicle accidents (27.2%) and domestic accidents (24.0%). Among domestic-related injuries, most of them (44.6%, n=37) occurred while playing, followed by do-it-yourself activities (21.7%, n=18) and falls (8.4%, n=7), while the remainder were sustained in a variety of different ways. The object causing open globe injury was most often metal (27.5%).

Table 1 Patient demographics and open globe injury-related circumstances

Variables	n=222 (%)
Gender	
M	175 (78.8)
F	47 (21.2)
Ethnicity	
Malay	207 (93.2)
Chinese	9 (4.1)
Indian	2 (0.9)
Others	4 (1.8)
Site of injury	
Home	115 (51.8)
Workplace	52 (23.4)
Street	41 (18.5)
School	6 (2.7)
Others	2 (0.9)
Not documented	6 (2.7)
Causes of injury	
Domestic-related	83 (37.4)
Occupational injury	52 (23.4)
Motor vehicle accident	39 (17.6)
Animal/agriculture-related	28 (12.6)
Others	20 (9.0)
Mechanism of injury	
Sharp	183 (82.4)
Intraocular foreign body	20 (9.0)
Blunt	14 (6.3)
Blast	5 (2.3)
Objects causing injury	
Metal	61 (27.5)
Glass	35 (15.8)
Sticks	23 (10.4)
Tools	18 (8.1)
Animal	18 (8.1)
Stone	10 (4.5)
Explosives	8 (3.6)
Wire	5 (2.2)
Toys	1 (0.4)
Others	29 (13.1)
Unknown	14 (6.3)

The most frequent mechanism of injury was sharp injury (82.4%), followed by intraocular foreign bodies (IOFB) blunt injury, and blast injury. In the 20 patients who had a retained IOFB, all but one of these were acquired *via* ocular laceration wounds. Removal of IOFB was successful in 17 out of these 20 cases.

Extension of the wound posteriorly was restricted to the cornea in 50.4% (Table 3). In approximately 70% of eyes, the length of the wound was less than 8 mm. About half of the cases had a hyphaema. Involvement of intraocular tissues

Table 2 Causes of open globe injury by age

Causes of injury	Age groups (a), n=222								Total
	1-5	6-10	11-15	16-25	26-35	36-45	46-55	>55	
Domestic-related	21	25	7	8	8	3	6	5	83
Occupational	0	0	2	19	15	7	9	0	52
Motor vehicle accidents	2	1	2	16	7	3	5	3	39
Animal/agriculture-related	8	9	6	1	1	1	2	0	28
Others/Not documented	0	7	7	1	3	1	1	0	20
Total	31	42	24	45	34	15	23	8	222

Table 3 Clinical data related to open globe injuries

Variables	n=222 (%)
Extension of wound posteriorly	
Restricted to the cornea	112 (0.4)
Anterior to recti insertion	79 (35.6)
Anterior to equator	21 (9.5)
Posterior to equator	10 (4.5)
Length of the wound	
1-4 mm	79 (35.6)
5-8 mm	81 (36.5)
9-12 mm	26 (11.7)
≥13 mm	36 (16.2)
Hyphaema	
None	105 (47.3)
Hyphaema <50%	68 (30.6)
Hyphaema >50%	49 (22.1)
Involvement of intraocular structures	
None	36 (16.2)
Uveal tissue prolapse only	80 (36.0)
Lens involvement only	26 (11.7)
Vitreous prolapse only	9 (4.1)
Involvement of ≥2 structures noted above	71 (32.0)
Surgical management	
Primary closure of eye wall wound alone	194 (87.4)
Primary closure of eye wall wound combined with anterior segment surgery only	21 (9.5)
Primary closure of eye wall wound combined with posterior segment surgery	5 (2.3)
Evisceration/enucleation	2 (0.9)
Complications	
Anterior segment complications[1]	72 (32.4)
Lens-related complications[2]	61 (27.5)
Posterior-segment complications	56 (25.2)
Phtisis bulbi	21 (14.0)
Sympathetic opthalmia	2 (0.9)

[1] *E.g.* corneal scar, iris damage, secondary glaucoma; [2] *E.g.* vitreous hemorrhage, retinal detachment, optic neuropathy.

(*e.g.* uvea, lens, vitreous) occurred in 83.8%, with uveal prolapse being the most common finding. Most cases were managed by primary surgical closure of the eye wall wound. Complications were uniformly distributed between the anterior segment, lens and posterior segment. Twenty one patients (14.0%) developed phtisis bulbi, and 2 developed sympathetic ophthalmia.

Unfortunately, the visual acuity at presentation was documented in only 115 eyes. Likewise, due to defaulters, the visual acuity at 6mo post operation was only available in 142 eyes. Most eyes (76.5%) had an initial visual acuity worse than 3/60, but many of them showed improvement postoperatively (Table 4). Overall, the final best corrected visual acuity at 6mo post operation was better than 6/12 in 35.2% of cases. This final visual acuity was found to be significantly associated with the initial visual acuity, posterior extent of wound, length of wound, presence of hyphaema and presence of vitreous prolapse (Table 4).

DISCUSSION

This study showed that males were more commonly involved than females, making up 78.8% of the total sample. Other studies in this field also demonstrated a male preponderance; Falcao *et al* [29] found that 76.0% of cases of traumatic open globe injury were males [26,30]. The possible reasons for the higher incidence of eye injuries in this group may be due to gender-based behaviour and male involvement in accident-prone industries.

The mean age of open globe injury in this study was 22.2y of age, which is lower than that of other studies in this area[31-33]. This variability may be a result of inter-population differences in culture, lifestyle, occupation and socioeconomic status, and has special implications with regard to proper implementation of a safe working environment.

The majority of open globe injuries occurred in the home (51.8%). This data is consistent with other large population studies related to open globe injuries, in which home-based accidents occurred in 38%-71% of cases [26,29]. In a study by Kadappu *et al* [21], the home was also the most common place of injury in children, which correlates with the findings of our study. However, Tok *et al* [34] and El-Sebaity *et al* [13] found that the home came second to the street in paediatric cases. Meanwhile, in adults, the most frequently associated cause in our series was occupational injury, which corresponds to results described in previous literature[32,35,36].

Sharp injuries contributed to 82.4% of cases in our study, which is higher than the proportion of 67.7% noted by Yalcin *et al* [32]. Although the most common mechanism of injury in our study was sharp injury, ordinal logistic regression

Table 4 Ordinal logistic regression analysis on factors affecting final visual outcome in open globe injuries

Variables	Coef.	Wald	95% CI	*P*
Initial visual acuity (*n*=115)				
>6/12	-3.155	8.175	(-5.317; -0.992)	0.004
6/12-3/6	-2.135	13.304	(-3.282; -0.988)	<0.000
<3/60[a]				
Mechanism of injury (*n*=142)				
Sharp injury	-1.435	1.272	(-3.930;1.059)	0.259
IOFB	-4.766E-008	0.000	(-2.690;2.690)	1.000
Blunt injury	-0.102	0.005	(-2.829; 2.624)	0.941
Blast injury [a]				
Posterior extent of wound (*n*=142)				
Restricted to the cornea	-20.506	868.619	(-21.869; -19.142)	<0.000
Anterior to recti insertion	-20.424	809.496	(-21.831; -19.017)	<0.000
Anterior to equator	-18.724	-	(-18.724; -18.724)	-
Posterior to equator [a]				
Length (*n*=142)				
1-4mm	-2.526	18.637	(-3.673; -1.379)	<0.000
5-8mm	-2.097	13.543	(-3.215; -0.980)	<0.000
9-12mm	-1.162	2.967	(-2.484; 0.160)	0.085
>13mm [a]				
Hyphaema (*n*=142)				
None	-2.488	25.018	(-3.464; -1.513)	<0.000
Hyphaema <50%	-1.882	13.374	(-2.890; -0.873)	<0.000
Hyphaema >50% [a]				
Presence of vitreous prolapse (*n*=142)				
None	-1.305	10.529	(-2.094; -0.517)	0.001
Present [a]				

[a]Reference level ; *P* <0.05 is significant.

analysis revealed that mechanism of injury was not significantly associated with final visual acuity (P>0.05). With regard to the object causing injury, metal and glass were most commonly implicated in this series, making up 43.3%, which is consistent with a study by Framme *et al* [26]. However, we found no association between the causative agent and the final outcome. Of greater significance was the impact of the object in terms of wound extension and damage to intraocular structures.

Posterior extension and length of the wound are important prognostic factors affecting the final visual outcome, as demonstrated by Thevi *et al* [35]. This relationship was likewise seen in our study, where posterior extension of wound was significantly associated with final visual acuity (P<0.001). In fact, subjects who had a wound extending posterior to the equator had 20 times the risk of having a final visual acuity less than 3/60 when compared with those whose wounds were anterior to the recti insertions or restricted to the cornea.

Han *et al* [31] established that a larger wound (>10 mm) was related to a poorer final visual acuity. Inversely, this study showed that the shorter the wound length, the better the final visual acuity. This suggests that the size of lacerations has not only therapeutic, but also prognostic implications; increase in length of laceration is significantly correlated with a worse visual outcome (P<0.001).

Other factors such as the presence of hyphaema or vitreous prolapse also play a role in final visual acuity. Subjects who did not have hyphaema were twice less likely to have a final visual acuity of less than 3/60 compared with subjects having hyphaema. However, this finding differed from that of Thevi *et al* [35], who found no significant effect of hyphaema on visual outcome. A similar finding was noted in subjects with vitreous prolapse, where those with vitreous prolapse had twice the risk of a final visual acuity less than 3/60 compared with those without vitreous prolapse (P<0.005). Yalcin *et al* [32] also found vitreous prolapse to be a significant prognostic factor influencing final visual acuity.

Presenting visual acuity has been found to be associated with visual outcome in multiple studies [31-33,35,37]. In a study by Rao *et al* [38], a visual acuity of <5/200 (equivalent to <1/60) was found to be the most important factor contributing to poor visual outcome. This study also noted initial visual presentation and visual outcome to be statistically significant, where subjects who had an initial visual acuity of >6/12 had three times less risk of having a final visual acuity worse than 3/60 (P=0.004).

The limitations of our study are related to insufficient documentation, especially in the area of presenting visual acuity. This may be related to circumstances surrounding the patient's admission to hospital, where inability to assess the visual acuity was due to medically unfit patients.

To sum up our findings, the most common causes of open globe injuries are domestic accidents and occupational injuries. Predictors of good visual outcome are initial visual acuity, posterior extent and length of wound, presence of hyphaema and presence of vitreous prolapse. An understanding of these prognostic factors may assist us in providing our patients with realistic expectations of final visual acuity. As yet, no organized efforts have been undertaken in the matter of primary prevention of open globe injuries. This data thus suggests a need to educate the public about safety precautions not only at work, but in the home. It also highlights the need to establish, implement and monitor compliance to guidelines in occupational safety and health.

ACKNOWLEDGEMENTS

The authors would like to thank Dr. Mohd Zulkarnain Sinor for his help in statistical analysis.

Conflicts of Interest: Madhusudhan, None; **Evelyn-Tai LM,** None; **Zamri N,** None; **Adil H,** None; **Wan-Hazabbah WH,** None.

REFERENCES

1 Eballe AO, Epee E, Koki G, Bella L, Mvogo CE. Unilateral childhood blindness: a hospital-based study in Yaounde, Cameroon. *Clin Ophthalmol* 2009;3:461-464

2 Abdu L. Prevalence and causes of blindness and low vision in Dambatta local government area, Kano State, Nigeria. *Niger J Med* 2002;11(3):108-112

3 May DR, Kuhn FP, Morris RE, Witherspoon CD, Danis RP, Matthews GP, Mann L. The epidemiology of serious eye injuries from the United States Eye Injury Registry. *Graefes Arch Clin Exp Ophthalmol* 2000;238(2):153-157

4 Nakamura Y, Tomidokoro A, Sawaguchi S, Sakai H, Iwase A, Araie M. Prevalence and causes of low vision and blindness in a rural Southwest Island of Japan: the Kumejima study. *Ophthalmology* 2010;117 (12): 2315-2321

5 Saw SM, Husain R, Gazzard GM, Koh D, Widjaja D, Tan DT. Causes of low vision and blindness in rural Indonesia. *Br J Ophthalmol* 2003;87(9): 1075-1078

6 Frick KD, Foster A. The magnitude and cost of global blindness: an increasing problem that can be alleviated. *Am J Ophthalmol* 2003;135(4): 471-476

7 Kinderan YV, Shrestha E, Maharjan IM, Karmacharya S. Pattern of ocular trauma in the Western Region of Nepal. *Nepal J Ophthalmol* 2012;4(7):5-9

8 Kanoff JM, Turalba AV, Andreoli MT, Andreoli CM. Characteristics and outcomes of work-related open globe injuries. *Am J Ophthalmol* 2010;150(2):265-269 e2.

9 Pandita A, Merriman M. Ocular trauma epidemiology: 10-year retrospective study. *N Z Med J* 2012;125(1348):61-69

10 Hossain MM, Mohiuddin AA, Akhanda AH, Hossain MI, Islam MF, Akonjee AR, Ali M. Pattern of ocular trauma. *Mymensingh Med J* 2011;20(3):377-380

11 Al-Mahdi HS, Bener A, Hashim SP. Clinical pattern of pediatric ocular trauma in fast developing country. *Int Emerg Nurs* 2011;19(4):186-191

12 Voon LW, See J, Wong TY. The epidemiology of ocular trauma in Singapore: perspective from the emergency service of a large tertiary hospital. *Eye (Lond)* 2001;15(Pt 1):75-81

13 El-Sebaity DM, Soliman W, Soliman AM, Fathalla AM. Pediatric eye injuries in upper Egypt. *Clin Ophthalmol* 2011;5:1417-1423

14 Desai P, MacEwen CJ, Baines P, Minassian DC. Epidemiology and implications of ocular trauma admitted to hospital in Scotland. *J Epidemiol Community Health* 1996;50(4):436-441

15 Khatry SK, Lewis AE, Schein OD, Thapa MD, Pradhan EK, Katz J. The epidemiology of ocular trauma in rural Nepal. *Br J Ophthalmol* 2004;88(4): 456-460

16 Soylu M, Sizmaz S, Cayli S. Eye injury (ocular trauma) in southern Turkey: epidemiology, ocular survival, and visual outcome. *Int Ophthalmol* 2010;30(2):143-148

17 Mensah A, Fany A, Adjorlolo C, Toure ML, Kasieu Gbe M, Mihluedo KA, Diallo AJ, Coulibaly F, Berete R. Epidemiology of eye injuries in Abidjanian children. *Sante* 2004;14(4):239-243

18 Brophy M, Sinclair SA, Hostetler SG, Xiang H. Pediatric eye injury-related hospitalizations in the United States. *Pediatrics* 2006;117(6):e1263-1271

19 Onakpoya OH, Adeoye A, Adeoti CO, Ajite K. Epidemiology of ocular trauma among the elderly in a developing country. *Ophthalmic Epidemiol* 2010;17(5):315-320

20 Serrano JC, Chalela P, Arias JD. Epidemiology of childhood ocular trauma in a northeastern Colombian region. *Arch Ophthalmol* 2003;121(10):1439-1445

21 Kadappu S, Silveira S Martin F. Aetiology and outcome of open and closed globe eye injuries in children. *Clin Experiment Ophthalmol* 2013; 41(5):427-434

22 Baker RS, Wilson RM, Flowers CW, Jr., Lee DA, Wheeler NC. A population-based survey of hospitalized work-related ocular injury: diagnoses, cause of injury, resource utilization, and hospitalization outcome. *Ophthalmic Epidemiol* 1999;6(3):159-169

23 Podbielski DW, Surkont M, Tehrani NN, Ratnapalan S. Pediatric eye injuries in a Canadian emergency department. *Can J Ophthalmol* 2009;44(5):519-522

24 Lee CH, Su WY, Lee L, Yang ML. Pediatric ocular trauma in Taiwan. *Chang Gung Med J* 2008;31(1):59-65

25 Saxena R, Sinha R, Purohit A, Dada T, Vajpayee RB, Azad RV. Pattern of pediatric ocular trauma in India. *Indian J Pediatr* 2002;69(10):863-867

26 Framme C, Roider J. Epidemiology of open globe injuries. *Klin Monbl Augenheilkd* 1999;215(5):287-293

27 Kuhn F, Morris R, Witherspoon CD. Birmingham Eye Trauma Terminology (BETT): terminology and classification of mechanical eye injuries. *Ophthalmol Clin North Am* 2002;15(2):139-143

28 Kuhn F, Morris R, Witherspoon CD, Mester V. The Birmingham Eye Trauma Terminology system (BETT). *J Fr Ophthalmol* 2004;27(2):206-210

29 Falcao M, Camisa E, Falcao-Reis F. Characteristics of open-globe injuries in northwestern Portugal. *Ophthalmologica* 2010;224(6):389-394

30 Pinna A, Atzeni G, Patteri P, Salvo M, Zanetti F, Carta F. Epidemiology, visual outcome, and hospitalization costs of open globe injury in northern Sardinia, Italy. *Ophthalmic Epidemiol* 2007;14(5):299-305

31 Han SB, Yu HG. Visual outcome after open globe injury and its predictive factors in Korea. *J Trauma* 2010;69(5):E66-72

32 Yalcin Tok O, Tok L, Eraslan E, Ozkaya D, Ornek F, Bardak Y. Prognostic factors influencing final visual acuity in open globe injuries. *J Trauma* 2011;71(6):1794-1800

33 Rofail M, Lee GA, O'Rourke P. Prognostic indicators for open globe injury. *Clin Experiment Ophthalmol* 2006;34(8):783-786

34 Tok O, Tok L, Ozkaya D, Eraslan E, Ornek F, Bardak Y. Epidemiological characteristics and visual outcome after open globe injuries in children. *J AAPOS* 2011;15(6):556-561

35 Thevi T, Mimiwati Z, Reddy SC. Visual outcome in open globe injuries. *Nepal J Ophthalmol* 2012;4(8):263-270

36 Altintas L, Altintas O, Yuksel N, Pirhan D, Ozkan B, Caglar Y. Pattern of open eye injuries in northwest Turkey: a retrospective study. *Ulus Travma Acil Cerrahi Derg* 2011;17(4):334-339

37 Rahman I, Maino A, Devadason D, Leatherbarrow B. Open globe injuries: factors predictive of poor outcome. *Eye (Lond)* 2006;20 (12): 1336-1341

38 Rao LG, Ninan A, Rao KA. Descriptive study on ocular survival, visual outcome and prognostic factors in open globe injuries. *Indian J Ophthalmol* 2010;58(4):321-323