Research Square

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Prognostic Factors and Epidemiology of Open Globe Injuries from Western Sydney: A Twelve-Year Review

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Abstract

Background

To identify prognostic factors determining final visual outcome following open globe injuries.

Methods

Retrospective case series of patients presenting to Westmead Hospital, Sydney, Australia with open globe injuries from 1st January 2005 to 31st December 2017. Data collected included demographic information, ocular injury details, management and initial and final visual acuities.

Results

A total of 104 cases were identified. Predictors of poor final visual outcomes included poor presenting visual acuity ($p < 0.001$), globe rupture ($p < 0.001$), retinal detachment ($p < 0.001$), Zone III wounds ($p < 0.001$), hyphema ($p=0.003$), lens expulsion ($p = 0.003$) and vitreous hemorrhage ($p < 0.001$). Multivariate analysis demonstrated presenting visual acuity ($p < 0.001$), globe rupture ($p = 0.013$) and retinal detachment ($p = 0.011$) as being statistically significant for predicting poor visual outcomes. The presence of lid laceration ($p = 0.197$) and uveal prolapse ($p = 0.667$) were not significantly associated with the final visual acuity.

Conclusions

Poor presenting visual acuity, globe rupture and retinal detachment are the most important prognostic factors determining final visual acuity following open globe injury.

Background

Open globe injury (OGI) is defined as a full thickness injury to the eye wall. Blunt trauma may cause globe rupture, whereas sharp trauma may be associated with penetrating or perforating injuries with or without an intraocular foreign body (IOFB). The Incidence of OGI in Australia has been reported to be 3.7/100 000 per annum[1, 2], similar to the United States at 3.49/100000 per annum[3]. Our understanding of OGIs has increased tremendously over the past decade thanks to the standardisation of terminology[4, 5] and prognostic parameters based on the Ocular Trauma Classification[6]. To our knowledge, there is no report on OGIs from Western Sydney. The closest we can find was a study on open globe injuries from 2010 to 2015 from Sydney Eye Hospital[7].

The purpose of this study was to identify prognostic factors for final visual outcome following OGIs presenting to a tertiary teaching hospital in Western Sydney, Australia.

Methods

A retrospective review of all patients with open globe injuries presenting to Westmead Hospital, Western Sydney Local Health District (WSLHD), Sydney, New South Wales, Australia from 1st January 2005 to 31st December 2017 was performed. Informed consent was obtained and ethics approved via the WSLHD Human Ethics Research Committee. Medical records were searched for the following diagnostic codes: S05.4 “Penetrating wound of orbit with or without foreign body”, S05.5 “Penetrating wound of eyeball with foreign body” or S05.6 “Penetrating wound of eyeball without foreign body” to identify relevant cases. Clinical notes, operative reports and any imaging performed (B-scans, X-rays, CT scans) were reviewed.

Data collected included: patient demographics, history of prior ocular trauma, cause of injury (hammer/ chisel, assault, fall, motor vehicle accident (MVA) or explosion/ blast), setting of injury (home or work related), association with alcohol or drug use, laterality and presenting and final visual acuity (VA). Best corrected VA was recorded from refracted vision, or pin hole vision if refraction was not performed. Snellen visual acuity was converted to LogMAR values. The types of injury was classified according to the Birmingham Eye Trauma Terminology (BETT) into globe rupture, penetrating injury, perforating injury and/or intraocular foreign bodies.(5) Wound location was classified into Zone I (full thickness wound involving the cornea only), Zone II (when the wound involves sclera not more posteriorly than 5 mm from the corneoscleral limbus) or Zone III (when the wound is posterior to Zone II).(6) The presence or absence of a relative afferent pupillary defect (RAPD), retinal detachment, hyphema, lens expulsion, vitreous hemorrhage, eyelid laceration or uveal prolapse at presentation were recorded. The ocular management and development of complications were also noted.

Statistical analysis was performed using SPSS Statistics v23 (IBM). Simple linear regression was used to correlate the presenting VA to final VA. Independent T-test was used to analyse each parameter. Generalised linear modelling was used for multivariant analysis to determine the main outcome predictors.

Results

A total of 104 eyes in 104 patients were identified. The mean age was 43 years (19 to 89, ± 17 years SD). Most patients were male (85%) with both sides being equally represented (right 53%, left 47%) (Table 1). The median follow-up period was 215 days (2 to 3554, interquartile range 508 days).

The most common cause of injury was from a hammer or chisel (33.7%) followed by “other” (29.8%), assault (14.4%), falls (10.6%), motor vehicle accidents (6.7%) and explosions/blasts (4.8%) (Fig. 1). Just over one-fifth of cases were work related (21.2%). Six (5.8%) cases were related to substance abuse (4 cases of alcohol related assault, 1 alcohol related fall and 1 drug related assault). Eight patients (7.7%) had previous ocular trauma (Table 1). Three patients had previous trauma to the same eye. Five patients had previous trauma to the other eye. One patient had dehiscence of penetrating keratoplasty from jumping into a pool of water.

Presenting VA was found to be a very strong predictor of final VA as shown in the linear regression model ($p < 0.001$). The patients stratified in two main groups of presenting VAs- equal or better than LogMAR 0.60 and LogMAR 2.00 or worse. Patients with presenting with VA ≤ LogMAR 0.60 usually had good final VA. In contrast, the group with initial VA ≥ LogMAR 2.00 was quite variable, some achieved excellent results while some did very poorly (Fig. 2).

Penetrating eye injuries accounted for over half of the open globe injuries (61%) followed by globe rupture (23%). An IOFB was present in 16% of eyes (Table 1). The type of injury was strongly correlated with final VA ($p < 0.001$). Penetrating eye injuries (LogMAR 0.80 ± 1.01) and IOFBs (LogMAR 0.84 ± 1.04) did very well, whereas globe ruptures did very poorly (LogMAR 2.28 ± 0.94). The presence of a retinal detachment was strongly correlated with final VA ($p < 0.001$). More posterior wounds were associated with worse final VAs ($p < 0.001$) with the mean final VAs in Zones I, II and III being LogMAR 0.86 ± 1.01, LogMAR 1.01 ± 1.16 and LogMAR 2.25 ± 1.01 respectively. Other statistically significant poor visual prognostic parameters were hyphema ($p = 0.003$), lens expulsion ($p = 0.003$) and vitreous hemorrhage ($p < 0.001$). Lid laceration ($p = 0.197$) and uveal tissue prolapse ($p = 0.667$) had no significant effect on the final visual outcome (Table 2).

A multivariate analysis using generalised linear model (GLM) of factors affecting final VA was carried out with SPSS Statistics v23 (IBM, Table 3). The assumptions of homogeneity of variances and normal distribution of residuals were checked and found to be valid. Three predictors of final VA were found to be strongly significant: presenting VA, mechanism of injury and retinal detachment. The other predictors were correlated with these three variables and could be omitted from the model without adversely affecting the goodness of fit. No interactions were found to be of statistical significance. The final GLM model with the three factors had an F-statistic of 14.736 ($p < 0.001$) and R^2 of 0.461, suggesting a high level of relationship between the factors and final VA, and an adequate goodness of fit. The parameter estimated for presenting VA predicting final VA was 0.41, which means each 1 logMAR of reduction in presenting VA results in 0.41 reduction of final VA (95% CI 0.22–0.60). Globe rupture had the worst prognosis of all injury mechanisms. Compared with globe ruptures, the final VA for penetrating eye injuries were better by a mean of 0.87 logMAR (95% C.I. 0.36–1.38) and IOFB were better by 0.72 logMAR (95% C.I. 0.08–1.36). The presence of retinal detachment worsened final VA by 0.73 logMAR (95% C.I. 0.17 to 1.29).

Of the 104 eyes, 97 (93%) eyes needed primary repair, with 7 (7%) presenting with self-sealing wounds. The mean duration from trauma to wound closure was 0.84 days (SD 1.95 days). Seventeen (16.3%) eyes received intravitreal antibiotics and 19 (18.3%) received intracameral antibiotics intraoperatively during primary surgery. While 93 (89.4%) patients received systemic antibiotics on presentation.

Thirty patients (28.8%) patients underwent pars plana vitrectomy (PPV). Retinal detachment (RD) was the most common indications for PPV with 15 cases. Other indications for PPV were: 5 IOFB, 4 dislocated lens, 3 vitreous hemorrhage, 2 endophthalmitis and 1 epiretinal membrane. 4 out of 5 (80%) IOFB, 1 out of 2 (50%) dislocated lens, 1 out of 2 (50%) endophthalmitis, 5 out of 15 (33.3%) of RD had PPV within 2 weeks post-trauma. There were some outliers. Case 18 had PPV for dislocated lens post-cataract surgery 4 years after the trauma. Case 16 had endophthalmitis from cataract surgery 5 months post-trauma (table 4). All PPVs were performed using 23G or 25G vitrector cutters.

Complications included 3 eyes with persistent wound leak after their primary repair. All 3 had re-suturing and 1 needed additional glue. There were 5 eyes that developed post-traumatic endophthalmitis. Another patient developed post-operative endophthalmitis following subsequent cataract surgery 5 months after the globe injury. Two cases underwent subsequent evisceration for painful blind eyes. There was no case of sympathetic ophthalmia.

Table 1
Baseline Data

Demographic data	n	%
Sex	88	85%
Male	16	15%
Female		
Laterality	55	53%
Right	49	47%
Left		
Work related	21	20%
Yes	83	80%
No		
Previous ocular trauma	8	8%
Yes	96	92%
No		
Substances abuse related	5	5%
Yes	99	95%
No		
Types of injury	24	23%
Globe rupture	17	16%
IOFB	63	61%
Penetrating eye injury		

Table 2
Clinical Factors Affecting Final Visual Acuity (LogMAR)

Variables	n	Final visual acuity (LogMAR)		P-value
		Mean	Standard Deviation	
Types of injury	24	2.28	0.94	< 0.001
Globe rupture	17	0.84	1.04	
IOFB	63	0.80	1.01	
Penetrating eye injury				
Retinal detachment	17	2.34	0.73	< 0.001
Yes	87	0.92	1.09	
No				
Wound Location	48	0.86	1.01	< 0.001
Zone I	39	1.01	1.16	
Zone II	17	2.25	1.01	
Zone III				
Hyphema	45	1.53	1.22	0.003
Yes	59	0.84	1.04	
No				
Lens expulsion	12	2.08	1.08	0.003
Yes	92	1.02	1.13	
No				
Vitreous hemorrhage	26	1.82	1.13	< 0.001
Yes	78	0.92	1.09	
No				
Eyelid laceration	16	1.49	1.32	0.197
Yes	88	1.08	1.14	
No				
Uveal prolapse	43	1.20	1.20	0.667
Yes	61	1.10	1.15	
No				

Table 3
Parameter Estimates From Generalised Linear Modelling Showing the Size of Effect of Significant Factors Affecting Final Visual Acuity

Parameter	Estimate	Standard Error	P-value	95% confidence interval
Presenting Visual Acuity	0.41	0.10	< 0.001	0.216 to 0.597
Injury Type	Globe rupture = 0	0.26	0.001	-1.378 to -0.358
	Penetrating = -0.87	0.32	0.028	-1.364 to -0.078
	IOFB = -0.72	0.92	0.563	-2.355 to 1.290
	Not specified = -0.53			
Retinal Detachment	Absent = 0	0.28	0.011	0.171 to 1.285
	Present = 0.73			

Discussion

The mean age for our study patients was 43-years-old (range, 18 to 89 years-old), which falls within the range of means reported by other Australian studies (30.4 to 44.8 years-old).[1, 2, 8] Westmead Hospital is an adult hospital and only accepts patients 14 years 9 months and older, so the demographic will be skewed towards older ages. The male preponderance (84.6%) in our cohort is slightly more than reported in other Australian studies (77.4–83.0%) [1, 2, 8] and much higher than reported in Japan (66.1%).[9] In our study, 21.3% OGI were work-related, similar to other Australian studies (18.6%-38.8%)[1, 2, 8] but less than that reported in a Japanese study (45.8%).[9] These variations could be due to the differences in culture and lifestyle. Besides that, the definition of work-related injury is loose. For instance, injuries sustained whilst working at home or not covered by workers' compensation may not have been counted.

Six cases (5.8%) of substance related OGI were reported in our study (4 alcohol and 1 drug-related assaults with 1 alcohol related fall). Thirty percent of the OGI caused by assaults were substance related. This is half of what has been reported in another Australian study, where 76.2% of assault were alcohol related.[1] In that study, the majority of the alcohol related assaults occurred in Aboriginals and Torres Strait Islanders, a demographic that is not frequently seen at Westmead Hospital.[1]

Multivariate analysis identified three main predictors of final VA: presenting VA, type of injury and presence of a retinal detachment. Although other factors such as zones of wound location, hyphema, lens expulsion and vitreous hemorrhage were also associated with final VA outcomes, they were all correlated with each other. For example, a ruptured globe is likely to have hyphema, vitreous hemorrhage and lens expulsion as well.

The Ocular Trauma Classification Group based its classification on four variables: initial VA, mechanism of injury, zone of wound location and presence of a RAPD as accurate predictors of final VA.[6] This is broadly in agreement with our study except we didn't analyse RAPD due to incomplete data (2 positive RAPD, 17 negative RAPD and 85 undocumented). However, we found another parameter, retinal detachment to be a strong predictive factor. It is possible that in the absence of a documented RAPD, retinal detachment may be used as a replacement for outcome prediction since a RAPD is often present when there is a large retinal detachment.

Initial VA is well established as one of the most important parameters determining final visual outcomes.[2, 6, 8, 9] Good vision reflects mild ocular damage, whereas poor vision reflects more extensive destruction which could result in injuries such as retinal detachment and vitreous hemorrhage.[6] In line with previous studies, our results show that globe rupture carries a poor visual prognosis.[2, 6, 8] Globe rupture which resulted from blunt injury causes more diffuse damage compared to sharp injuries such as penetrating eye injuries and IOFBs which cause local damage.[6] In agreement with previous studies[6, 9], Zone III wounds were associated with a poorer visual prognosis in our study. These wounds involve posterior structures such as the retina and optic nerve which heal poorly and lack regenerating ability.[6]

Retinal detachment, hyphema, lens expulsion and vitreous hemorrhage have been reported to be associated with poor visual outcomes.[2, 6, 8, 9] This usually results from severe ocular trauma in association with other ocular tissue damage. In agreement with some[2] but not all[8] studies, uveal prolapse was not shown to be a significant predictor of final visual outcome.

Eyelid laceration has previously been reported to be associated with poor outcomes.[10] Lid laceration and adnexal injuries have been associated with blunt trauma and severe ocular injury with increased likelihood of posterior globe injuries.[10] However, we did not find this association in our study and had more sharp injuries such as penetrating eye injury (n = 8) and IOFB (n = 1) than globe ruptures (n = 7) associated with lid laceration.

The numbers of vitrectomised eyes are not large enough for meaningful analysis of correlation between timing of surgery and visual acuity. However, we note that the indication for early vitrectomy (within 2 weeks post-trauma) was highest for IOFB (80%), followed by lens dislocation (50%), endophthalmitis (50%), retinal detachment (33.3%), vitreous hemorrhage (0%) and epiretinal membrane (0%). This likely reflects the urgency required to remove an IOFB, delayed presentations of endophthalmitis, retinal detachment and epiretinal membrane, delayed diagnosis of retinal detachment in a traumatised eye with media opacity and decisions to observe vitreous hemorrhage which may spontaneously resolve.

Our study has limitations including its retrospective nature, a short follow-up period due to patients being discharged to private rooms, the presence of tamponade agents (12 eyes, 11.5%) at final follow-up making visual acuity readings difficult to interpret, poor documentation of RAPD, use of pin-hole instead of refracted BCVA in some patients and poor documentation of the time of injury, meaning that the time of wound closure could only be calculated to days and not hours. Despite this, it is a reasonably large cohort with significant findings of those parameters which were accurately documented.

Conclusion

Poor presenting visual acuity, globe rupture and retinal detachment are the most important prognostic factors determining final visual acuity following OGI. The presence of retinal detachment should be considered in future classification schemes of OGI, especially when the presence of a RAPD has not been documented. Uveal prolapse and eyelid laceration had no statistically significant effect on visual prognosis.

Declarations

Ethics approval and consent to participate

Informed consent was obtained and ethics approved via the WSLHD Human Ethics Research Committee.

Consent for publication

No individual data has been presented.

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available as individual privacy may be compromised but can be made available from the corresponding author on reasonable request.

Competing interests

All authors have no competing interests (financial or non-financial).

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Authors' contributions

HH, JF, SB and CG collated the dataset. YL provided statistical analysis. HH, JC and AF conceptualised and supervised the research and performed the surgery. HH and AF were the main writers of the manuscript. All authors read and approved the final manuscript.

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Not applicable

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Figures

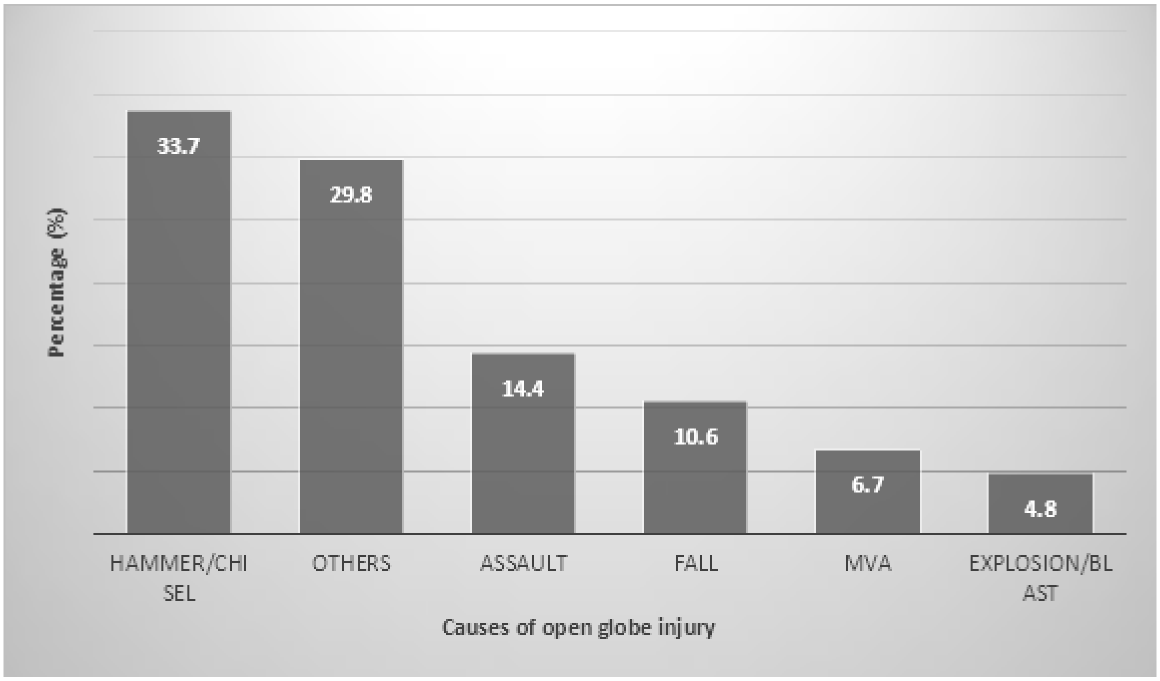

Figure 1

Causes of Open Globe Injury

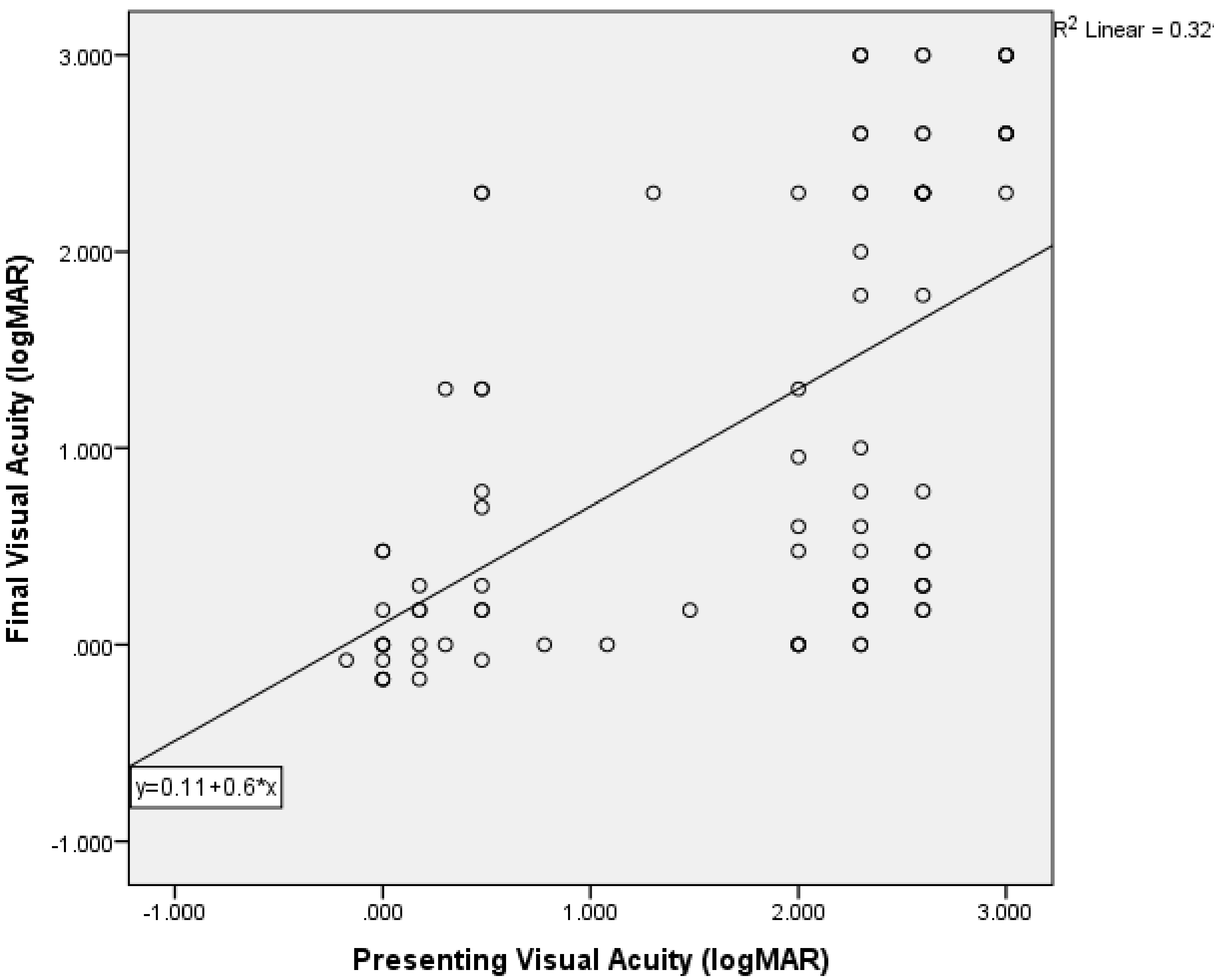

Figure 2

Graph of Presenting Versus Final Visual Acuity