·Clinical Research·

Visual outcomes in patients with open globe injuries compared to predicted outcomes using the Ocular Trauma Scoring system

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Abstract

• AIM: To determine the visual outcomes in adult patients who sustained open globe injuries and to determine whether the visual prognosis following an eye injury in an African setting differs from the predicted outcomes according to the Ocular Trauma Score (OTS) study. A secondary aim was to establish the evisceration rate for these injuries and assess how this form of intervention affected outcomes in comparison to the OTS.

• METHODS: A prospective case series of all patients admitted with open globe injuries over a two-year (July 2009 to June 2011) period. Injuries were scored using the OTS and the surgical intervention was recorded. The best corrected visual acuity at three months was regarded as visual outcome.

• RESULTS: There were 249 open globe injuries, of which 169 patients (169 eyes) completed the 3-month follow-up. All patients underwent primary surgery, 175 (70.3%) repairs, 61 (24.5%) eviscerations and 13 (5.2%) other procedures. Globe eviscerations were mainly done on OTS Category 1 cases, but outcomes in this category were not found to be different from OTS outcomes. Outcomes were significantly worse in Category 2, but when the entire distribution was tested, the differences were not statistically significant. The overall association between OTS outcomes and the final visual outcomes in this study was found to be a strong (P <0.005).

• CONCLUSION: Reliable information regarding the expected outcomes of eye injuries will influence management decisions and patient expectations. The OTS is a valuable tool, the use of which has been validated in many parts of the world-it may also be a valid predictor in an African setting.

• **KEYWORDS:** ocular trauma; open globe injuries; Ocular Trauma Score; evisceration and visual outcomes

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INTRODUCTION

Many cases of open globe injury (OGI) are admitted to Groote Schuur Hospital (GSH) each year and a large number of these patients undergo primary eviscerations [1]. Although the presenting visual acuity (VA) in the traumatised eye has been reported to be a strong individual predictor of final vision [2-8], and is widely accepted as such, it is not always the case and there are a few studies which show otherwise [9-11]. The Ocular Trauma Score (OTS) was developed to inform of the likelihood of having a specific visual outcome following a serious eye injury, predicting the final vision and thus assist with the accurate counselling of patients[3].

Kuhn *et al* [12] noted that the ophthalmologist cannot rely on existing published data when trying to predict the visual outcome after a serious eye injury because virtually all variables that are described to have predictive value in certain reports are claimed to have no impact on the outcome in other studies. Also, even studies in which a particular variable is found to have prognostic value, the actual point at which this becomes important is so different that it is rendered almost meaningless for clinical practice *e.g.* the length of the wound and its location [9]. These authors also mention that the ophthalmologist's chosen treatment method and expertise is another potential source for bias [9]. The OTS was therefore proposed after the analysis of a data base of over 2500 injuries with more than 100 variables being assessed. In calculating the OTS, different scores are given to certain variables that are present on initial examination of ocular trauma cases. These include the presenting VA, the type of injury and the presence of certain complicating factors. The score thus obtained is used to predict the likelihood of the patient having a specific VA (within one of five groups) after treatment.

Since the management of OGIs in our setting (where primary eviscerations are often performed in treating OGIs), may differ from that which was used to establish the OTS, the question arises as to whether the visual prognosis in cases of OGI admitted to GSH differs from or still conforms to the predicted outcomes using the OTS system. There have been studies published on the validity of using the OTS system in Europe and Asia[6,13], but no such study has been conducted in Africa.

This study was aimed at determining the visual outcomes in adult patients who sustained OGIs (and were admitted to GSH) and to determine whether the visual prognosis following an eye injury differs from the predicted outcomes according to the OTS study. A secondary aim was to establish the evisceration rate for these injuries and assess how this form of intervention affected outcomes in comparison to the OTS study.

SUBJECTS AND METHODS

Data were prospectively collected on all patients admitted to GSH with an OGI over the two-year period from the beginning of July 2009 to the end of June 2011. On admission, the resident ophthalmologist examined each patient, documented the findings and recorded them on a standardised assessment sheet. Presenting VA, presence or absence of afferent pupillary defect (APD) and the grade of injury were recorded in all cases. The acuities were then scored using the OTS to give an initial score. The type of surgical intervention was recorded and the patient followed up for a minimum period of three months.

Injuries were graded according to the Birmingham Eye Trauma Terminology (BETT)[14] system and adapted from the OTS as follows:

1) Type of OGI: A. rupture; B. penetrating; C. intra-ocular foreign body (IOFB); D. perforating; E. mixed;

2) Grade (according to Snellen visual acuity in metres): A. 6/12 or better; B. 6/15 to 6/30; C. worse than 6/30 to 1/36; D. 1/60 to light perception (LP); E. no LP (NLP);

3) Zone of injury: Ⅰ. cornea and limbus; Ⅱ. limbus up to 5 mm into sclera; Ⅲ. more than 5 mm from limbus.

The initial score was obtained by taking the "raw points" allocated to the grade of injury (according to presenting VA in feet) from the OTS[9]: NLP=60; LP/HM (hand movements) =70; 1/200-19/200=80; 20/200-20/50=90; ≥20/40=100.

The final score was calculated by taking the initial score and subtracting the appropriate amounts as indicated by OTS for: rupture; endophthalmitis; perforating injury; retinal detachment; and afferent pupil defect. Otherwise the initial score from the VA grouping became the final score. The best corrected Snellen VA recorded at three months was deemed to be the visual outcome which was compared to the predicted outcome according to the OTS.

A customised template in Microsoft Access was used to collect data to minimize data entry errors. The information was analysed after completion of the three-month follow-up visit using Stata (version 11.1). Means and standard deviations (SD) were reported for normally-distributed variables. The groups were compared using the appropriate statistical test to describe the differences (if any) between the expected outcomes (using the OTS) and the actual outcomes at three months. Proportions were compared using the t-test and, where appropriate, Fisher's exact test and regression analysis. Factors were considered statistically significant if $P<0.05$.

Patient anonymity was strictly maintained, informed consent was obtained from all patients and the study was conducted in keeping with the Declaration of Helsinki. Ethical approval for the study was obtained from the Ethics Committee of the Faculty of Health Sciences, University of Cape Town.

RESULTS

There were 249 patients admitted to the Ophthalmology ward with OGIs during the designated two-year period. These included 212 (85.14%) males and 37 (14.86%) females. The mean age for males was 32.6±11.7y and females 34.5±14.8y. Only 169 of these patients completed the 3-month follow-up and were included in the statistical analysis.

Patients with OGIs underwent primary surgery in all 249 cases. These primary procedures included 175 (70.3%) repairs, 61 (24.5%) eviscerations and 13 (5.2%) other procedures (including pars plana vitectomies). Secondary procedures for all 249 cases within the three-month period included (amongst others): 12 secondary eviscerations (4.8% of total) and four (1.6%) retinal detachment repairs. Primary eviscerations were performed in those patients in whom, as far as possible, the following criteria were all present: VA of no light perception, an afferent pupil defect, a normal fellow eye, irreparable wounds and informed patient consent. Due to limited theatre resources, retinal detachment repairs were only performed in those with compromised fellow eyes and injuries with reasonably good prognoses.

The presenting VA of our patients (divided according to the OTS acuity groups) can be seen in Table 1. The OTS categories were used for grouping the data of this study (Table 2). The cases in each category were further divided into zones (Table 2).

It is understood from the OTS system that if, for example, a patient had an OTS score of between zero and 44, this case would fall into "OTS Category 1" and 74% of patients in this category end up with a VA of NLP; 15% achieve an outcome of HM to LP; 7% have an outcome of count fingers (CF) to 5/60; 3% achieve 6/18 to 6/60; and 1% get 6/5 to 6/12. Each category can be predicted in this way according to the OTS (see "OTS" columns in Table 3).

Table 1 Presenting VA according to OTS system

VA groups (OTS)	Number (*n*=169)	Percentage (*n*=100)
6/5-6/12	5	2.96
6/15-6/60	7	4.14
5/60-CF	10	5.92
HM-LP	99	58.58
NLP	48	28.4

Table 2 OTS scores, categories and zones for cases in this study *n* (%)

Score	OTS category	Zone Ⅰ	Zone Ⅱ	Zone Ⅲ	Total (*n*=169)
0-44	1	5	6	27	38 (22.49)
45-65	2	13	9	44	66 (39.05)
66-80	3	23	10	14	47 (27.81)
81-91	4	10	3	0	13 (7.69)
92-100	5	3	2	0	5 (2.96)

Table 3 Comparison of outcomes with the OTS study

OTS category	NLP (including eviscerations)		HM-LP		CF		6/18-6/60		6/5-6/12	
	GSH	OTS	GSH	OTS	GSH	OTS	GSH	OTS	GSH	OTS
1	75.68	74	18.92	15	5.41	7	0	3	0	1
2	50.56[a]	27[a]	36.14[a]	26[a]	7.23[a]	18[a]	3.61[a]	15[a]	2.41[a]	15[a]
3	4.69	2	15.63	11	32.81[a]	15[a]	28.13	31	18.75[a]	41[a]
4	0	1	0	2	12.50[a]	3[a]	6.25[a]	22[a]	81.25	73
5	0	0	0	1	0	1	0	5	100	94

[a] The significant differences in percentages.

After dividing the total of 169 patients who completed the study into the OTS categories, the following figures indicate the percentages of each category (with final VA of NLP) that were made up of primary eviscerations: 40.54 (of the 75.68%) in "Category 1"; 6.02 (of the 50.56%) in "Category 2"; 1.56 (of the 4.69%) in "Category 3"; and no eviscerations in Categories 4 and 5 - see second column of Table 3. All patients who underwent evisceration in the 169 cases that were analysed did complete the full three month follow-up period.

Table 3 shows the differences in outcomes between the findings of this study and those of the OTS study. When the major differences in proportions ([a]) were further tested, most of them were found to be significant (Table 4). When the entire distribution of outcomes was tested, it was not statistically significant using either the Kruskall-Wallis (P= 0.2175) or Chi-square (P=0.1873) tests. When the Chi-square test was used to assess the significance of association between OTS outcomes and the final visual outcomes in this study, there was found to be a strong association between the OTS score and visual outcome (P<0.005).

However, it is clear from the above that our patients tend to do worse for "Category 2" as a whole and for only parts of "Categories 3 and 4". For "Categories 1 and 5", the outcomes are similar.

Table 4 Significance testing of proportions for categories with major differences

Category/VA	Significant difference?	*P*
Cat. 2/NLP	Yes	0.00804
Cat. 2/HM-PL	Yes	0.0114
Cat. 2/CF	No	0.126
Cat. 2/6/18-6/60	Yes	0.00804
Cat. 2/6/5-6/12	Yes	0.00096
Cat. 3/CF	Yes	0.0188
Cat. 3/6/5-6/12	Yes	0.0007
Cat. 4/CF	Yes	<0.05
Cat. 4/6/18-6/60	Yes	0.00112

DISCUSSION

The finding that most patients sustaining ocular trauma are young males is a well-reported fact that needs no further discussion. Severe trauma is known to be a common indication for the removal of a globe, usually in unsalvageable cases. In rural Africa it is known to be the third commonest indication (for globe removal) after severe infections and degenerative diseases [15]. Almost 30% of the patients with OGIs at GSH underwent primary or secondary eviscerations. This is higher than the rates of around 14%-17% reported in the more recent literature [2,4,5,10], but similar to the rate of around 35% found in a previous study done in our department [1]. There also seems to have been a downward trend in the rate of globe removal after trauma over the years, with a study in 1996 reporting a 24%-30% rate [16]. This decrease is probably due to the more recent advances in intra-ocular surgery and vitreoretinal techniques that have made it possible for more globes which might have been removed in the past to be salvaged. Our higher evisceration rate may be due to the more serious nature of the injuries in our setting, as evidenced by more patients presenting with poor vision (Table 1). It may also be due to the fact that, due to the limited resources at our disposal, vitreoretinal procedures and all-out attempts at sparing the globe are reserved for those cases regarded to have better prognoses (only 1.6% of total cases underwent retinal detachment repair). This figure, by comparison, is far lower than the 24.7% (48 out of 194) patients who had vitreoretinal intervention in a study by Han and Yu [5] which was aimed at validating the OTS in Korea. Feng *et al* [11] also claim that

traumatized eyes with complete blindness may be restored in a limited way to light perception or better vision if vitreoretinal surgery is attempted.

Cases that underwent globe evisceration were mainly found in "OTS Category 1". Outcomes in these "Category 1" cases with poor prognosis eyes were not different from outcomes in the OTS study; indicating that the evisceration rate had no effect on the final VA. This is most likely due to the severe nature and poor prognosis of these injuries. Unver *et al*[13] found that they had significantly fewer patients with NLP in "Category 1" than in the OTS study and they attributed this finding to a lower rate of globe removal (enucleation/ evisceration) in their patients than at the time of the OTS study. Han and Yu [5] also found better outcomes for "Categories 1 and 2" in their study.

In "Category 2", about 12% of the patients who ended up with monocular blindness had undergone evisceration. The whole of "Category 2", with the exception of one group, had a significantly worse outcome than in the OTS study and this was probably due more to the lack of vitreoretinal intervention than globe evisceration, since evisceration would only have affected the group with NLP vision. These were also noted to be mainly "Zone III" injuries (Table 2) which were more likely to have had retinal involvement. In "Category 3", the outcomes in those with NLP vision were no different from the OTS study and thus evisceration rates did not seem have an effect on this group at all. The number of cases in "Categories 3 and 4" who had reasonably good outcomes was fewer in our study than in the OTS. This could be explained by the fact that there were relatively few patients who presented with good acuities (less severe injuries) and also a lower number of cases in these categories with better prognoses. Another explanation is that due to the shortage of corneal graft material in our setting, corneal grafts are only offered to patients that are bilaterally affected, whereas most trauma cases only have one eye involved and are therefore not offered grafts at all.

If the entire distribution of OTS categories is taken into consideration, there is no statistically significant difference between the outcomes of OGIs in this study and the OTS study. Significant differences were only detected in certain categories when they were compared directly. This may be due to the case numbers in the OTS being greater than in our study and this fact may have contributed to the overall outcome trends being similar. The usefulness of the OTS in serious eye injuries has been shown in numerous papers from North America, Europe and Asia [6-8,13], as well as in specific scenarios such as paediatric eye injuries and deadly weapon-related OGIs [17,18]. This is the first study from Africa analysing the relevance of the OTS.

The studies on OGI and the OTS mentioned in the above paragraph include retrospective analyses on adults and children from various parts of the world (Turkey, Korea, Canada and UK)[5,6,8,10,13,17-20]. There are no prospective studies reported. The strength of our study is that it was conducted prospectively, since all of the recent studies on this subject were retrospective. A limitation of our study is that despite the fairly large number of cases (249) overall, just over two-thirds (169) of these completed the three-month follow-up period and were included in the statistical analysis. When these were further broken down into sub-groups according to OTS categories, the numbers became even smaller. The problem of poor follow-up in our middle income setting is well-recognised [1]. Further prospective studies with larger numbers and longer follow-up periods are warranted.

As noted by Kuhn *et al* [12], it is important for patients and ophthalmologists to have early, reliable information regarding the expected outcomes of serious eye injuries. Having a reasonably accurate functional prognosis influences management decisions as well as patient expectations, "the OTS is easy to calculate and has major significance for the injured patient, for the treating ophthalmologist, and for all other public health professionals who are interested in the eye injury scene in general" [9]. The OTS is thus a valuable tool with a reported 77% chance of correctly predicting the final visual outcome within (plus or minus) one visual category[12]. Although other systems and modified OTS systems that may predict outcomes after OGI have been proposed in adults and children [7,21], the OTS system has been validated and can provide valuable prognostic information. Our apparently higher evisceration rate in cases of OGI does not appear to significantly affect overall outcomes compared to the OTS. The OTS may still be a valid predictor of visual outcome (with the possible exception of a few categories) in an African setting.

Method of Literature Search The literature search for this section was performed using the online electronic Medline PubMed search up to September 2014. The keywords searched included: ocular trauma, penetrating eye injuries, evisceration, enucleation, open globe, ocular injury, ocular trauma score, ocular trauma classification, outcomes and treatment. Combinations of these terms were used as well. After finding relevant articles within these search limits, a manual search was conducted through the references. Abstracts from the non-English literature were also surveyed.

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