

An Evaluation of the Precision of Ocular Trauma Score and Factors for Poor Visual Outcomes in Open Globe Injury: A Retrospective Analysis of Resource-limited Hospital Settings

Takarn Oughtkaew, M.D.¹, Siwatus Puangrab, M.D.^{2,*}

¹Department of Ophthalmology, Bueng Kan Hospital, Bueng Kan, Thailand, ²School of Medicine, Walailak University, Nakhon Si Thammarat, Thailand.

ABSTRACT

Objective: To evaluate the accuracy and validity of ocular trauma scores (OTS) among patients with open globe injury (OGI) in rural hospital settings and to identify the determinants predicting poor visual outcomes.

Materials and Methods: A single-center retrospective cohort study was conducted through a chart review of OGI patients between July 2018 and June 2023 at Bueng Kan Hospital. Demographic and preoperative factors affecting the final visual outcome were evaluated. OTS score for each patient was calculated and categorized. Final visual acuity (VA) after 6 months was compared to the predicted VA from OTS study. Poor visual outcome was defined as legal blindness after 6 months of treatment.

Results: Thirty-nine eyes from patients with a mean age of 44.05 years were evaluated. Most subjects were male (94.87%), and workplace injuries were the most common (78.38%). Compared to the OTS study, patients in OTS category 2 achieved a significantly higher percentage of better final VA, while categories 3 and 4 showed similar outcomes. OTS category 1 patients had a lower proportion of no light perception (NLP) outcomes, though the difference was not significant. Poor visual outcomes were predicted by initial VA (OR=4.64), wound extension ≥ 10 mm (OR=20.66), and lens injury (OR=7.44).

Conclusion: OTS is beneficial for predicting final vision in patients with OGI, particularly with less severe trauma. Severe cases can sometimes result in better-than-expected visual outcomes, emphasizing the need for cautious management and counseling by ophthalmologists. Factors that estimate poor visual outcomes involve poor initial VA, wound extension ≥ 10 mm, and lens damage.

Keywords: Eye injury; prognosis; ocular trauma score; rural area; resource-limited setting (Siriraj Med J 2024; 76: 696-704)

INTRODUCTION

Open globe injury (OGI) is a serious but preventable eye condition and remains a national public health concern. OGI can lead to permanent visual loss, resulting in limitation of daily life activities as well as psychiatric issues.¹ Previous studies have shown more incidences in young adults and high etiology in occupational-related

injuries.²⁻⁶ Based on recent reports, a global incidence of OGI ranging between 3.40 and 12 per 100,000 population was noted.^{4,7-9}

Not only are treatment and visual rehabilitation crucial processes to achieve favorable outcomes, but the management of a patient's vision expectation is also a challenging topic. To date, a significant amount of

*Corresponding author: Siwatus Puangrab

E-mail: si_watus@hotmail.com

Received 27 July 2024 Revised 18 August 2024 Accepted 26 August 2024

ORCID ID: <http://orcid.org/0000-0002-4564-2993>

<https://doi.org/10.33192/smj.v76i10.270374>



All material is licensed under terms of the Creative Commons Attribution 4.0 International (CC-BY-NC-ND 4.0) license unless otherwise stated.

research has been conducted to find the determinants of visual outcomes after OGI.^{2-6,8,10-12} Ocular trauma score (OTS) is a simplified categorical system commonly used to assess visual acuity after treatment by using simple six parameters from an initial eye examination.^{13,14} Validation of OTS in OGI is also widely studied, mostly at tertiary eye centers, and the results tend to be useful for counseling impacted patients and their families.^{5,10,12} Although OTS is reliable and reproducible to estimate the best corrected visual acuity (BCVA) after treatment,¹⁵⁻¹⁷ some studies found patients with OGI have the actual BCVA better than BCVA predicted by OTS especially in more severe injuries (categories 1 and 2).^{12,18} Recent publications about the validation of OTS found that the effectiveness of OTS to estimate BCVA for overall categories is still inconclusive. Further research is necessary to develop an optimized ocular trauma prognosticating system.¹⁹

In resource-limited settings, cost-effectiveness is frequently concerned, and treatment options are often restricted so these can influence final visual outcome. Moreover, there is limited literature on the validation of OTS at hospitals with limited resources, especially those available only to general ophthalmologists.

This study aims to evaluate the accuracy and validity of OTS in patients with OGI in resource-limited hospital settings and to identify the factors predicting poor visual outcomes.

MATERIALS AND METHODS

This study was conducted with consideration for the Declaration of Helsinki and Council for International Organizations of Medical Sciences (CIOMS) guideline and received approval from the research ethics committee at Bueng Kan Hospital (research number: BKHEC2023-47). The medical records of patients who were diagnosed with OGI between July 2018 and June 2023 at Bueng Kan Hospital were reviewed retrospectively. The definition of OGI strictly followed based on the Birmingham Eye Trauma Terminology (BETT)²⁰, including penetrating ocular injury, perforating ocular injury, ruptured globe, and intraocular foreign body (IOFB). Patients under the age of 15 years old who could not be evaluated for visual acuity or had concurrent ocular diseases or loss to at least 6-months follow-up were excluded. The collected data included age, gender, mechanism of injury, causative objects, and time to hospital, as well as initial eye examination, associated injury, and visual status at the most recent visit. The location of injury was defined by the most posterior point of the wound into 3 zones, comprising zone 1 for an injury limited to the cornea and limbus, zone 2 for an injury involving anterior 5 mm

of sclera from the limbus, and zone 3 for an injury involving beyond posterior 5 mm from the limbus.²¹ The raw score of OTS was calculated from the initial eye examination and classified into 5 categories. Final visual outcome was evaluated by BCVA at least 6 months after trauma and used for evaluating the accuracy of OTS. Poor visual outcome was defined as legal blindness by evaluate the $BCVA \leq 3/60$ (Snellen equivalent of 20/400) or 1.3 LogMAR after 6 months of treatment.

Statistical analysis

For descriptive statistics, continuous data including age, time to hospital, and visual acuity were analyzed using mean and standard deviation (SD) or median and interquartile range (IQR). Categorical data including gender, activity, and mechanism of injury, as well as causative objects, zone of injury, and other factors affecting OGI, were analyzed by percentage.

The patients were grouped into poor visual outcome group (legal blindness) and good visual outcome group (non-legal blindness). The association between final visual outcome and predictive determinants, including demographic data, initial VA, mechanism of injury, wound location, lens injury, relative afferent pupillary defect (RAPD), retinal detachment, vitreous hemorrhage, IOFB, endophthalmitis and eyelid injury were analyzed using univariate and multivariate logistic regression.

Based on the OTS scoring system, the actual and predicted final VA in each category were assessed by testing for equality of proportion. Statistical analysis was calculated using the STATA program, and a P-value less than 0.05 was considered significant.

RESULTS

Forty-five patients were diagnosed with OGI, all with unilateral involvement. Six patients were excluded with two subjects lost to follow-up, two were pediatric patients, and two others had missing data. Remaining 39 patients were analyzed with a mean age (SD) of 44.05 (16.57) years old. Most subjects were male ($n=37$, 94.87%), and workplace ($n=29$, 78.38%) was the most common setting for eye injury. In this study, occupational-related activities including mowing ($n=11$, 28.21%) and agriculture ($n=9$, 23.08%) were found to be frequent activities. For causative objects, high-velocity objects ($n=11$, 28.21%) were more common than others, followed by wood branches from agricultural activities. The median (IQR) time to hospital was 3 (2,15) hours. The demographic data and circumstances causing OGI comparing between poor and good final visual outcome are shown in Table 1.

TABLE 1. Comparison of patients' demographic data and circumstance causing Open Globe Injury (OGI) between poor and good final visual outcome group.

Patient's Characteristics	Final Visual Outcome Group		P-value
	Poor (n=18)	Good (n=21)	
Age in years (SD)	39.86 (17.56)	47.63 (15.16)	p = 0.927 ^a
Sex n, %			
Male	17 (94.44)	20 (95.24)	p = 0.911 ^b
Female	1 (5.56)	1 (4.46)	
Setting n, %			
Workplace	14 (77.78)	15 (71.43)	p=0.031 ^c
Home	4 (22.22)	0 (0.00)	
Traffic	0 (0.00)	1 (4.76)	
Outdoor	0 (0.00)	3 (14.29)	
Recreation	0 (0.00)	1 (4.76)	
Assault	0 (0.00)	1 (4.76)	
Activity n, %			
Mowing	6 (33.33)	5 (23.81)	p=0.567 ^c
Gardening	3 (16.67)	6 (28.57)	
Repair	4 (22.22)	2 (9.52)	
Sport	1 (5.56)	0 (0.00)	
Blunt	3 (16.67)	3 (14.29)	
Sharp	1 (5.56)	3 (14.29)	
Firework	0 (0.00)	2 (9.52)	
Causative object n, %			
High-velocity metal	1 (5.56)	5 (23.81)	p=0.108 ^c
High-velocity object	8 (44.44)	3 (14.29)	
Metallic	2 (11.11)	2 (9.52)	
Wood	1 (5.56)	6 (28.57)	
Glass	2 (11.11)	1 (4.76)	
Elastic	3 (16.67)	1 (4.76)	
Stone	1 (5.56)	2 (9.52)	
Explosive	0 (0.00)	1 (4.76)	
Time to hospital (hour), Median (IQR)	3 (2,15)	4 (2,9)	p = 0.7950 ^d

Note: NA, not applicable. Statistical test notations: 'a' represents the independent t-test; 'b' denotes the Pearson chi-square; 'c' denotes Fischer's exact test; 'd' denotes the Mann-Whitney U test.

Most patients (n=24, 61.54%) initially presented with VA of light perception (LP) and hand movement (HM) followed by 1/200-19/200 (n=5, 12.82%), 20/200-20/50 (n=5, 12.82%). Four patients (n=4, 10.26%) presented with NPL, and one patient (2.56%) had VA better than 20/40. At the 6 months follow-up, most eyes showed improvement in visual acuity. Fig 1 shows the distribution of initial VA and final VA at 6 months follow-up in each OTS category. Patients presenting with VA of NLP or LP/HM were often classified into OTS categories 1

and 2, indicating more severe injuries. No patients in OTS category 1 attained a final VA better than PL/HM. Conversely, patients in OTS category 2 exhibited a wider range of final VA outcomes compared to other groups.

For assessing the accuracy of OTS, half of them (n=20, 51.28%) were initially grouped in category 2 at the first visit, while 10 eyes (25.64%) were in category 1, 8 eyes (20.51%) were in category 3, and one eye (2.56%) was grouped in category 4. However, no eye in this study was classified as category 5. The final VA of patients in

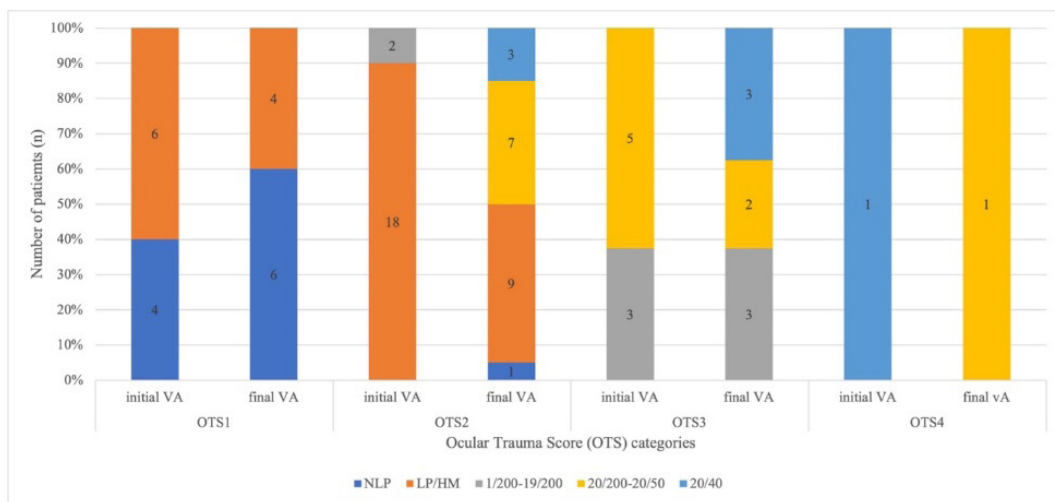


Fig 1. Distribution of Initial VA and final VA classified into each OTS category.

Note: OTS1, OTS category 1. OTS2, OTS category 2. OTS3, OTS category 3. OTS4, OTS category 4. No patients in OTS category 5. Initial VA, initial visual acuity. Final VA, visual acuity at 6 months follow-up.

each category were grouped into five final VA groups, as shown in Table 2. There was no significant difference in patients with OTS categories 3 and 4 between this study and the OTS study. However, patients with OTS category 2 had the significantly lower percentage of NLP group than the OTS study. There were increase in the proportion of LP/HM group and achieved significantly higher percentage of 20/200 to 20/50 group than the OTS study. In patients with OTS category 1, the majority of final VA was still in NLP group like the OTS study even though the insignificantly lower proportion of patients with final VA of NLP than the OTS study was observed. The percentage comparison of final visual acuity between the OTS study and this study classified into each category is shown in Table 2.

In this study, the average initial VA for overall patients was 2.3 LogMAR (Snellen equivalent of 20/3990). Rupture globe was found to be the major mechanism of injury (n=20, 51.28%) followed by penetrating ocular injury (n=16, 41.03%). Zone 1 injury was the most common wound location (n=18, 46.15%). At the first ophthalmic evaluation, 22 eyes (56.41%) were found to have lens injury, while 18 eyes (46.51%) had a relative afferent pupillary defect (RAPD). Retinal detachment and vitreous hemorrhage were also found in 6 (15.38%) and 8 (20.51%) eyes, respectively. Two eyes (5.13%) showed evidence of endophthalmitis, and 2 other eyes (5.13%) had concurrent eyelid laceration. For univariate regression analysis, many factors predict poor visual outcomes, including initial VA ($p<0.001$), penetrating ocular injury ($p=0.033$), wound zone 3 ($p=0.025$), wound extension greater than or equal to 10 mm ($p<0.001$), lens

injury ($p<0.001$) and RAPD ($p<0.001$). Comparisons and differences between final visual outcome groups are shown in Table 3.

For multivariate analysis, factors predicting poor final visual acuity include initial VA (OR=4.64, 95%CI=1.33-16.22), wound extension greater than or equal to 10 mm (OR=20.66, 95%CI=2.07-206.18) and lens injury (OR=7.44, 95%CI=1.20-45.95). Other factors that did not show significant differences are detailed in Table 4.

Eight patients (20.51%) were referred to a tertiary eye center due to IOFB, retinal detachment, and endophthalmitis, while the remaining 31 eyes (79.49%) could be treated at rural hospitals. Consequently, twenty-two eyes were found to have traumatic cataracts. The median (IQR) initial VA of patients with traumatic cataracts was 2.5 (2.3-2.7) LogMAR. Nine of them underwent cataract surgery with or without intraocular lens implantation. The median final VA of patients who underwent cataract surgery was 1.51 LogMAR. As the baseline initial VA of patients with lens injuries differed significantly between those who underwent cataract surgery and those who did not ($p = 0.02$), linear regression was employed to adjust for baseline differences in presenting VA. The results indicate that patients with lens injuries who received cataract surgery exhibited a significantly better final VA compared to those who did not undergo surgery, with a difference of 0.78 LogMAR ($p = 0.016$).

DISCUSSION

Among ocular injuries overall, OGI ranks as a high-risk problem in terms of visually-threatening conditions. Worldwide incidence varies and runs to 12 per 100,000

TABLE 2. Distribution of Final Visual Outcome for Patients at Final Follow-up Compared Between Ocular Trauma Score Study and This Study

OTS Category	Data Set (N)	Final Visual Acuity Group									
		NLP % (95%CI)	P value	LP/HM % (95%CI)	P value	1/200 to 19/200 % (95%CI)	P value	20/200 to 20/50 % (95%CI)	P value	20/40 and better % (95%CI)	P value
1	OTS (215)	73		17		7		2		1	
	This study (10)	60.0 (29.3-90.4)	0.3545	40.0 (9.6-70.4)	0.0528	0.0 (0.0-0.0)	0.3856	0.0 (0.0-0.0)	0.6514	0.0 (0.0-0.0)	0.7506
2	OTS (374)	28		26		18		13		15	
	This study (20)	5.0 (4.6-14.6)	0.0220	45 (23.2-66.8)	0.0527	5 (4.6-14.6)	0.1302	35 (14.1-55.9)	0.0034	10 (3.1-23.1)	0.5312
3	OTS (808)	2		11		15		28		44	
	This study (8)	0.0 (0.0-0.0)	0.6862	0.0 (0.0-0.0)	0.3200	37.5 (4.0-71.0)	0.0747	25 (5.0-55.0)	0.8501	37.5 (4.0-71.0)	0.7111
4	OTS (378)	1		2		2		21		74	
	This study (1)	0.0 (0.0-0.0)	0.9199	0.0 (0.0-0.0)	0.8864	0.0 (0.0-0.0)	0.8864	100	0.0524	0.0 (0.0-0.0)	0.0916
5	OTS (376)	0		1		2		5		92	
	This study (0)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note: NA, not applicable. The p-value was calculated by comparing independent proportions.

TABLE 3. Characteristics of eyes sustaining open globe injury by final vision status.

Eye Characteristics	Number of eyes, %	Final Visual Outcome Group		P-value
		Good (n=18)	Poor (n=21)	
Presenting VA, (LogMAR)				
Median (IQR)	2.3 (1.9,2.7)	2.1 (1,2.3)	2.7 (2.3,2.7)	p<0.001 ^a
Mechanism of injury				
1 rupture	20 (51.28)	7 (38.89)	13 (91.90)	Reference
2 penetrate	16 (41.03)	11 (61.11)	5 (23.81)	p=0.033
3 perforate	0 (0.00)	0 (0.00)	0 (0.00)	N/A
4 IOFB	3 (7.69)	0 (0.00)	3 (14.29)	p=0.230
Wound Zone				
Zone 1	18 (46.15)	9 (50.00)	9 (42.86)	Reference
Zone 2	15 (38.46)	9 (50.00)	6 (28.57)	p=0.546
Zone 3	6 (15.38)	0 (0.00)	6 (28.57)	p=0.025
Wound extension				
Extent <10 mm	26 (66.67)	17 (94.44)	9 (42.86)	Reference
Extent ≥10 mm	13 (33.33)	1 (5.56)	12 (57.14)	p<0.001
Lens injury	22 (56.41)	5 (27.78)	17 (80.95)	p<0.001
RAPD	18 (46.51)	1 (5.56)	17 (80.95)	p=0.001
Retinal detachment	6 (15.38)	1 (5.56)	5 (23.81)	p=0.113
Vitreous hemorrhage	8 (20.51)	3 (16.67)	5 (23.81)	p=0.590
Endophthalmitis	2 (5.13)	0 (00.00)	2 (5.13)	p=0.180
Eyelid laceration	2 (5.13)	1 (5.56)	1 (4.76)	p=0.913

Note: NA, not applicable. Statistical test notation: 'a' denotes the Wilcoxon Test.

TABLE 4. Multivariable exploratory analysis for factors associated with poor vision following open globe injury.

Eye Characteristics	Odds Ratio	95% CI	P-value
Age	1.03	0.98 - 1.08	0.274
Female	1.04	0.043 - 25.14	0.982
Presenting VA, (LogMAR)	4.64	1.33 - 16.22	0.016
Mechanism of injury			
1 rupture	Reference		
2 penetrate	0.24	0.06 - 1.00	0.049
3 perforate	N/A		
4 IOFB	N/A		
Wound Zone			
Zone 1	Reference		
Zone 2	0.45	0.08 - 2.57	0.371
Zone 3	N/A		
Wound extension			
Extent <10 mm	Reference		
Extent ≥10 mm	20.66	2.07 - 206.18	0.010
Lens injury	7.44	1.20 - 45.95	0.031
RAPD	4.05	0.23 - 72.17	0.341
Retinal detachment	1.18	0.03 - 49.69	0.930
Vitreous hemorrhage	1.56	0.32 - 7.70	0.550
Endophthalmitis	N/A		
Eyelid laceration	0.25	0.009 - 6.93	0.412

Note: NA, not applicable

people per year based on the latest report in the US.⁹ In this study, young male adults with occupational-related situations face a high risk of OGI. This finding was correlated with agricultural activity in this area and similar to prior reports at several tertiary centers that showed most patients were young men with either work-related or domestic injuries.^{15,18,22} The revelation that workplace-related incidents are the leading cause of OGIs in this study advocates for stringent safety protocols and the adoption of protective eyewear to mitigate risk. The role of high-velocity objects and natural elements like wood branches as prevalent causative agents further underscores the need for targeted preventive strategies in specific occupational and recreational settings.

Half of the patients in this study were classified by OTS as category 2, followed by categories 1, 3, and 4, respectively. Patients with high raw OTS scores represented less severe OGI, which was graded in the higher category. On the other hand, patients with lower raw OTS scores had more severe injuries, which were graded in a lower category. In less severe patients, there was no significant difference between the percentage of predicted final visual outcomes in the OTS group and this study group. In OTS category 2, the significantly lower proportion of final VA in NLP group was noted. Furthermore, the proportion of patients in the LP/HM group increased, and they achieved a significantly higher percentage in the final VA of 20/200 to 20/50 compared to the OTS study. For patients classified as OTS category 1, most had final visual acuity (VA) in the NLP group, similar to the OTS study, although there was a slightly lower proportion of patients with final VA in the NLP group compared to the OTS study, but this difference was not statistically significant. These results may show a more favorable final visual outcome in patients with more severe OGI when predicting final VA by OTS. Similar to other research in various tertiary centers, such as in China, OTS prediction was not significantly different when compared with actual visual outcomes postoperatively in OTS categories 3, 4, and 5 ($P > 0.05$), while the prognosis of patients with OTS categories 1 and 2 was better than OTS study ($P=0.001, 0.007$), respectively.²³ In Korea, final visual acuities assessed using OTS categories were similar to those of OTS study in OTS categories 3, 4, and 5, and more favorable in OTS categories 1 and 2.¹² Northern Thailand reported a lower proportion of poor visual outcomes for eyes in OTS categories 1 and 2, while a concordance in proportions was observed in eyes in OTS categories 3 and 4.² From this study, there is agreement to be cautious in management, especially in the case of severe OGI. The authors' observation of

better-than-anticipated visual outcomes in lower OTS categories challenges the score's predictive accuracy in the unique settings of this study. This discrepancy invites a critical evaluation of the applicability of OTS beyond the original scoring system, suggesting that local environmental, clinical, and possibly occupational factors could influence injury outcomes. This finding aligns with studies questioning the universal applicability of OTS, advocating for context-specific adaptations to enhance its prognostic relevance.

For the predictive determinants of visual outcomes, many other centers report that presenting VA is one of the strong predictive factors affecting visual prognoses.^{9,15,17,22,24-29} Furthermore, other factors include RAPD, posterior involvement, length of wound, rupture mechanism, retinal detachment, and endophthalmitis. Other studies found the presence of adnexal injuries is another influential factor affecting visual outcomes.²⁶ and a significant increase risk of secondary enucleation.³⁰ Moreover, traumatized eyes with no light perception require vitreoretinal surgery. It was also found that ciliary body damage, severe vitreous hemorrhage, and closed funnel RD increase the risk of no light perception after treatment. Analysis in this study indicated that the factors predicting poor final visual outcomes include poor initial VA ($OR=4.64$, $95\%CI=1.33-16.22$), wound extension more than 10 mm ($OR=20.66$, $95\%CI=2.07-206.18$), and lens injury ($OR=7.44$, $95\%CI=1.20-45.95$). Penetrating ocular injury may contribute to achieving more favorable vision than other mechanisms of injury ($OR=0.24$, $95\%CI=0.06-1.00$). The identification of initial VA, wound extension, and lens injury as predictors of poor visual outcomes is consistent with existing literature, emphasizing their universal prognostic significance. These factors underscore the complexity of OGI management, where a multifaceted approach considering both clinical findings and the mechanism of injury is pivotal. The variation of influential factors between publications may be attributed to the mode of injury, population, surgical instrument technology, experience of surgeon, and cataract surgery following primary surgical repair. Further study in a larger population and subgroup analysis are needed to clarify the associated predictive determinants.

Literature reports exist about the effect of time on surgery and final visual outcomes. The time lag between the injury and surgery was found to adversely affect the final visual outcomes.³¹ Another study by Blanch RJ et al. found that time to primary repair is essential by a reduction in predicted visual acuity of 0.37 LogMAR for every 24 hours of delay ($95\% CI 0.14$ to 0.6).³² In contrast, a report from Makhoul KG et al. found that the time

to repair OGI within 24 hours did not influence the final VA.³³ Patients in rural areas also had significantly worse final VA than city dwellers and had higher rates of endophthalmitis and enucleation.³⁴ Rural patients had a longer time elapsed from injury to presentation ($P = 0.023$, average 12.04 hours vs 7.53 hours).³⁵ Due to the long distance from a nearby tertiary care center, the median time (IQR) to the hospital in this study was 3 (2,15) hours, and no significant difference was found between the final visual outcome group ($p=0.8$). However, the absence of a significant association between time to hospital presentation and visual outcomes in this study contrasts with existing evidence. This divergence could reflect the unique aspects of the study settings, such as variability in injury severity, access to care, or the small number of patients for evaluation, thus warranting further investigation.

The current study, while offering valuable insights, is not without limitations. The retrospective design and sample size may limit the generalizability of the findings of this study. Additionally, the unique socioeconomic and healthcare context of the settings in this study may influence the applicability of the results of this study to other regions. Future research should aim to validate and refine prognostic tools like the OTS in diverse settings, incorporating larger, multicentric cohorts to capture the broad spectrum of factors influencing OGI outcomes. Investigating the impact of timely intervention, advanced surgical techniques, and rehabilitation services in resource-limited settings will further elucidate pathways to optimizing care for OGI patients.

CONCLUSION

In resource-limited settings, OTS is suitable for predicting final vision in patients with OGI, especially in less severe trauma. A more favorable final visual outcome can be found in severely injured cases, highlighting the need for ophthalmologists to be cautious in management and counseling. The factors predicting poor visual outcomes include poor initial VA, wound extension of more than 10 mm, and lens injury.

ACKNOWLEDGMENTS

The authors extend their deepest gratitude to the patients and their families whose participation was essential for this research. Sincere appreciation is also extended to the medical and support staff at Bueng Kan Hospital for their assistance in data collection and patient care.

Special thanks go to the Department of Ophthalmology at Bueng Kan Hospital and the School of Medicine at Walailak University for their support and the resources they

provided, which were indispensable for the achievement of this study. The authors are also grateful to the research ethics committee for their approval and guidance throughout this project.

This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The support provided by institutions was crucial for the completion of this work.

Author Contributions

T.O. conceived the idea, designed the protocol, prepared the abstract, wrote and edited the manuscript. S.P. refined the methodology, analyzed the data, and reviewed the final manuscript.

REFERENCES

1. Keles A, Karayagmurlu A, Yetkin E, Sonmez K, Karatepe MS, Karaman SK. Development of posttraumatic stress disorder and depression after open globe injury in adults. *Graefes Arch Clin Exp Ophthalmol*. 2023;261(1):257-62.
2. Porapaktham T, Choovuthayakorn J, Nanegrungsunk O, Phinyo P, Tanasombatkul K, Watanachai N, et al. Open Globe Injury in a Tertiary Hospital of Northern Thailand: No Vision Survival and Ocular Trauma Score. *Clin Ophthalmol*. 2023;17:365-73.
3. Choovuthayakorn J, Worakriangkrai V, Patikulsil D, Watanachai N, Kunavisarut P, Chaikitmongkol V, et al. Epidemiology of Eye Injuries Resulting in Hospitalization, a Referral Hospital-Based Study. *Clin Ophthalmol*. 2020;14:1-6.
4. Batur M, Seven E, Esmer O, Akaltun MN, Yasar T, Cinal A. Epidemiology of Adult Open Globe Injury. *J Craniofac Surg*. 2016;27(7):1636-41.
5. Wang W, Zhou Y, Zeng J, Shi M, Chen B. Epidemiology and clinical characteristics of patients hospitalized for ocular trauma in South-Central China. *Acta Ophthalmol*. 2017;95(6):e503-e10.
6. Peleja MB, da Cunha FBS, Peleja MB, Rohr JTD. Epidemiology and prognosis factors in open globe injuries in the Federal District of Brazil. *BMC Ophthalmol*. 2022;22(1):111.
7. Mir TA, Canner JK, Zafar S, Srikumaran D, Friedman DS, Woreta FA. Characteristics of Open Globe Injuries in the United States From 2006 to 2014. *JAMA Ophthalmol*. 2020;138(3):268-75.
8. Ozturk T, Cetin Dora G, Ayhan Z, Kaya M, Arikan G, Yaman A. Etiology and Visual Prognosis in Open Globe Injuries: Results of A Tertiary Referral Center in Turkey. *Sci Rep*. 2019;9(1):17977.
9. Tomaiuolo M, Woreta FA, Li A, Yonekawa Y, Zhang QE, Sharpe JE, et al. Open-Globe Injury Repairs in the American Academy of Ophthalmology IRIS(R) Registry 2014-2018: Incidence, Risk Factors, and Visual Outcomes. *Ophthalmology*. 2023;130(8):812-21.
10. Agrawal R, Wei HS, Teoh S. Prognostic factors for open globe injuries and correlation of ocular trauma score at a tertiary referral eye care centre in Singapore. *Indian J Ophthalmol*. 2013;61(9):502-6.
11. Fujikawa A, Mohamed YH, Kinoshita H, Matsumoto M, Uematsu M, Tsuiki E, et al. Visual outcomes and prognostic factors in open-globe injuries. *BMC Ophthalmol*. 2018;18(1):138.

12. Han SB, Yu HG. Visual Outcome After Open Globe Injury and Its Predictive Factors in Korea. *J Trauma*. 2010;69(5):E66-72.
13. Kuhn F, Maisiak R, Mann L, Mester V, Morris R, Witherspoon CD. The Ocular Trauma Score (OTS). *Ophthalmol Clin North Am*. 2002;15(2):163-5.
14. Yu Wai Man C, Steel D. Visual outcome after open globe injury: a comparison of two prognostic models--the Ocular Trauma Score and the Classification and Regression Tree. *Eye (Lond)*. 2010;24(1):84-9.
15. Shir Yen W, Siu Wan F, Che Hamzah J, Khoo Kah Luen K. Epidemiology and Visual Outcome of Open Globe Injury Cases in Hospital Pulau Pinang. *Cureus*. 2021;13(11):e19648.
16. Bruce CN, Beal CJ, Zou B. Visual Outcomes and Prognostic Factors for Pediatric Open Globe Injuries. *Pediatr Emerg Care*. 2022;38(2):e439-e442.
17. Shrestha SM, Anthony CL, Justin GA, Thapa M, Shrestha JB, Khatri A, et al. Factors affecting final functional outcomes in open-globe injuries and use of ocular trauma score as a predictive tool in Nepalese population. *BMC Ophthalmol*. 2021;21(1):69.
18. Sahin Atik S, Ugurlu S, Egrilmez ED. Open Globe Injury: Demographic and Clinical Features. *J Craniofac Surg*. 2018;29(3):628-31.
19. Tan SI, Hoskin AK, Khatri A, Dave VP, Bhalarao S, Romero J, et al. Prognostic factors of open-globe injuries: A review. *Indian J Ophthalmol*. 2023;71(12):3587-94.
20. 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):139-43.
21. Pieramici DJ, Sternberg P Jr, Aaberg TM Sr, Bridges WZ Jr, Capone A Jr, Cardillo JA, et al. A system for classifying mechanical injuries of the eye (globe). The Ocular Trauma Classification Group. *Am J Ophthalmol*. 1997;123(6):820-31.
22. Supreeyathitikul P, Chokesuwattanaskul S, Choovuthayakorn J, Patikulsila D, Watanachai N, Kunavisarut P, et al. Epidemiology and Outcomes Following Open Globe Injury in Agricultural Region, an 11-Year Experience. *Ophthalmic Epidemiol*. 2020;27(4):246-51.
23. Guo T, Shi W, Yi X, Huang T, Huang P, Xue K. Clinical evaluation and management of badminton-related eye injuries: a retrospective case series. *BMC Ophthalmol*. 2023;23(1):258.
24. Page RD, Gupta SK, Jenkins TL, Karcioğlu ZA. Risk factors for poor outcomes in patients with open-globe injuries. *Clin Ophthalmol*. 2016;10:1461-6.
25. Mayer CS, Reznicek L, Baur ID, Khoramnia R. Open Globe Injuries: Classifications and Prognostic Factors for Functional Outcome. *Diagnostics (Basel)*. 2021;11(10):1851.
26. Gupta R, Gupta S, Chauhan L. Predicting visual outcome after open globe injury using classification and regression tree model: the Moradabad ocular trauma study. *Can J Ophthalmol*. 2019;54(4):473-8.
27. Ho H, Foo J, Li YC, Bobba S, Go C, Chandra J, et al. Prognostic factors and epidemiology of adult open globe injuries from Western Sydney: a twelve-year review. *BMC Ophthalmol*. 2021;21(1):173.
28. Li EY, Chan TC, Liu AT, Yuen HK. Epidemiology of Open-Globe Injuries in Hong Kong. *Asia Pac J Ophthalmol (Phila)*. 2017;6(1):54-8.
29. Madhusudhan AP, 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):486-90.
30. Rahman I, Maino A, Devadason D, Leatherbarrow B. Open globe injuries: factors predictive of poor outcome. *Eye*. 2006;20(12):1336-41.
31. Agrawal R, Rao G, Naigaonkar R, Ou X, Desai S. Prognostic factors for vision outcome after surgical repair of open globe injuries. *Indian J Ophthalmol*. 2011;59(6):465-70.
32. Richard JB, Jonathan B, Hedayat J, Philip Ian M. Effect of time to primary repair on final visual outcome after open globe injury. *Br J Ophthalmol*. 2019;103(10):1491-4.
33. Makhoul KG, Bitar RA, Armstrong GW, Weinert MC, Ivanov A, Kahale F, et al. Effect of time to operative repair within twenty-four hours on visual acuity outcomes for open globe injuries. *Eye*. 2023;37(11):2351-5.
34. Rofail M, Lee GA, O'Rourke P. Prognostic indicators for open globe injury. *Clin Exp Ophthalmol*. 2006;34(8):783-6.
35. Fu R, Kancherla S, Eller AW, Yu JY. Characteristics and Outcomes of Open Globe Trauma in the Urban versus Rural Population: A Single Center Retrospective Review. *Semin Ophthalmol*. 2018;33(4):566-70.