• Clinical Research •

Predictive value and applicability of ocular trauma scores and pediatric ocular trauma scores in pediatric globe injuries

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Abstract

● **AIM:** To evaluate the predictive value and applicability of Ocular Trauma Score (OTS) and Pediatric Ocular Trauma Score (POTS) for closed and open globe injuries in the pediatric group.

● **METHODS:** A retrospective study of closed and open globe injuries in children age of 0-18-year-old between 2012-2019 was conducted. Medical records were collected, and injuries were classified using Birmingham Eye Trauma Terminology System (BETTS). The predictive value and applicability of both OTS and POTS to final visual acuity (VA) were analyzed.

● **RESULTS:** Of 84 patients, 59 (70.2%) presented with closed globe injuries (CGI) and 25 (29.8%) with open globe injuries (OGI). The mean of initial VA was 0.832±0.904 logMAR. OTS and POTS was calculated. Initial VA (P<0.001) and traumatic cataract (P<0.001) were significantly associated with visual outcome, followed by organic/unclean wound (P=0.001), delay of surgery (P=0.001), iris prolapse (P=0.003), and globe rupture (P=0.008). A strong correlation between OTS and POTS and final VA (r=-0.798, P<0.001; r=-0.612, P<0.001) was found. OTS was more applicable in all age group of pediatric and in contrast to POTS, it was designed for 0-15 years old. POTS requires eleven parameters and OTS six parameters. Even though initial VA was not available, we could still calculate into POTS equation.

● **CONCLUSION:** OTS and POTS are highly predictive prognostic tools for final VA in CGI and OGI's in children.

● **KEYWORDS:** ocular trauma score; pediatric ocular trauma; closed globe injuries; open globe injuries; eye injuries

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INTRODUCTION

Ocular trauma is a major cause of monocular blindness in developed countries[1]. Approximately 2.4 million cases of ocular trauma occur in the United States annually, of which 35% are in patients aged 17 and younger[2-3]. Eye trauma to pediatric patients results in specific challenges and amblyopia among children seven years of age or younger is commonly reported[4-6].

Birmingham Eye Trauma Terminology System (BETTS) defines globe injuries as closed globe injuries (CGI) and open globe injuries (OGI)[7-8]. Ocular Trauma Score (OTS) has been widely applied to predict visual outcome[9]. Two criteria in the OTS, can be challenging to ascertain in injured children, presenting visual acuity (VA) and relative afferent pupillary defect (RAPD)[10]. Acar *et al*[11] developed Pediatric Ocular Trauma Score (POTS) which reduces the influence of presenting VA in its predictive model and removes RAPD. The

prognoses for OGI's has improved tremendously in the last decades[12]. The aim of this study was to evaluate the predictive value and applicability of both OTS and POTS for CGI and OGI's in pediatric presenting to a tertiary eye hospital in Jakarta, Indonesia.

SUBJECTS AND METHODS

Ethical Approval This study was approved by Ethics Committee of Medical and Health Research Ethics Committee (MHREC) Faculty of Medicine, Public Health and Nursing Universitas Gadjah Mada - Dr. Sardjito General Hospital Ref No. KE/FK/0645/EC/2020 and complied with the tenets of the Declaration of Helsinki. Informed consent to participate was obtained from all patients and guardians.

General Data For our retrospective study, Electronic Medical Records (EMR) of all cases of pediatric globe injuries presenting to Jakarta Eye Center (JEC) Eye Hospitals between 2012 and 2019 were collected. Patients were identified through EMR searching for the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes including S04, S05 (S05.0-S05.9), and S09. Children were defined as individuals 0-18 years of age.

Patient records were reviewed to determine age, gender, initial and final VA. Patients who had VA data for six months following initial trauma were included in analysis. The authors classified the eye injuries in accordance with BETTS and OTS Classification Group by Kuhn *et al*[7-9]. The OTS and POTS parameters were calculated and analyzed for their predictions on visual outcome included initial VA, globe rupture, endophthalmitis, perforating injury, retinal detachment, RAPD, age, wound location, concomitant eye pathologies including iris prolapse, hyphema, organic/unclean injury, delay of surgery >48h, traumatic cataract, vitreous hemorrhage. POTS was calculated and evaluated for the age group of 0-15-year-old (for which it was designed). Both scores were used to assign patients a Group number between 1 and 5. Group 1 represents the poorest prognosis and 5 the best. Association between Group and final VA was examined. The applicability of OTS and POTS was assessed.

Statistical Analysis All data was entered into Microsoft Excel spreadsheet. Snellen VA was converted to logarithm of minimal angle resolution (logMAR) equivalent for statistical analysis. Statistical analysis was performed using SPSS Statistics for Mac version.25 (SPSS Inc., Chicago, Illinois, USA). Linear regression of analysis of variance (ANOVA) was used to evaluate the predictive value of initial VA to final VA. The Spearman's rank correlation coefficient was used to evaluate the predictive value of OTS and POTS with final VA. A *P*-value of <0.01 was considered statistically significant. Normally distributed parameters are reported as mean±standard deviation (SD).

Table 1 Age group, gender and type of injury

Description	CGI	OGI	Total, *n* (%)
Age, y			9.85±4.98
0-2	3	2	5 (6.0)
3-5	7	6	13 (15.5)
6-10	19	12	31 (36.9)
11-18	30	5	35 (41.7)
Gender			
Boys	42	20	62 (73.8)
Girls	17	5	22 (26.2)

CGI: Closed globe injuries; OGI: Open globe injuries.

Table 2 The OTS and POTS categories and type of injury

Category	CGI	OGI	Total, *n* (%)
OTS			62 (100)
1	0	2	2 (3.2)
2	5	12	17 (27.4)
3	8	1	9 (14.5)
4	8	0	8 (12.9)
5	26	0	26 (41.9)
POTS			69 (100)
1	1	5	6 (8.7)
2	11	5	16 (23.2)
3	7	8	15 (21.7)
4	11	7	18 (26.1)
5	14	0	14 (20.3)

CGI: Closed globe injuries; OGI: Open globe injuries; OTS: Ocular trauma scores; POTS: Pediatric ocular trauma scores.

RESULTS

A total of 84 patients (eyes) met the inclusion criteria over the eight years period examined. CGI represented the majority of patients (59/84, 70.2%) and OGI was reported in 29.8% (25/84) patients. The 11-18 years old (35/84, 41.7%) represented the largest proportion of injured patients. A higher proportion of boys (62/84, 73.8%) than girls were represented in the data across all age groups. Age group, gender and type of injury are described in Table 1.

Initial uncorrected visual acuity (UCVA) was able to be obtained in 62 children with mean 0.832±0.904 logMAR (range 0-3.0 logMAR). Overall, the majority patients had UCVA of ≥20/40 on the affected eye at presentation (29/62, 34.5%; Figure 1). Best-corrected visual acuity (BCVA) at presentation was recorded in 58 patients.

Of 62 children were assigned to the OTS group and 69 children were assigned to the POTS group (Table 2). A strong correlation between OTS, POTS and final visual outcome was identified (Spearman's correlation: r=-0.798, P<0.001; r=-0.612, P<0.001, respectively). Using linear regression ANOVA, we observed that initial VA was a significant

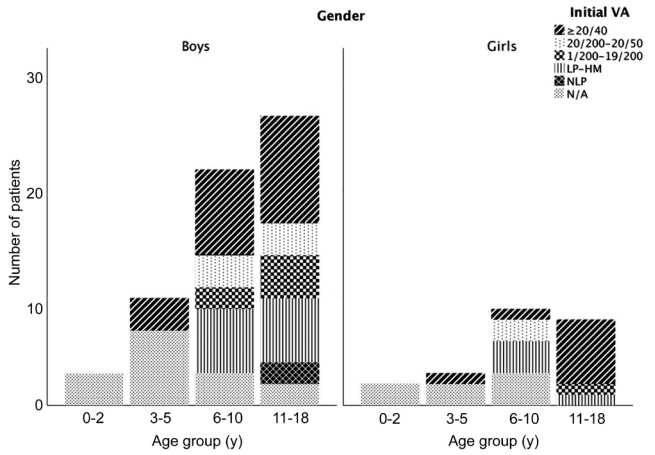

Figure 1 Initial visual acuity, age of group, and gender VA: Visual acuity; LP: Light perception; NLP: No light perception; HM: Hand movements; N/A: Not available.

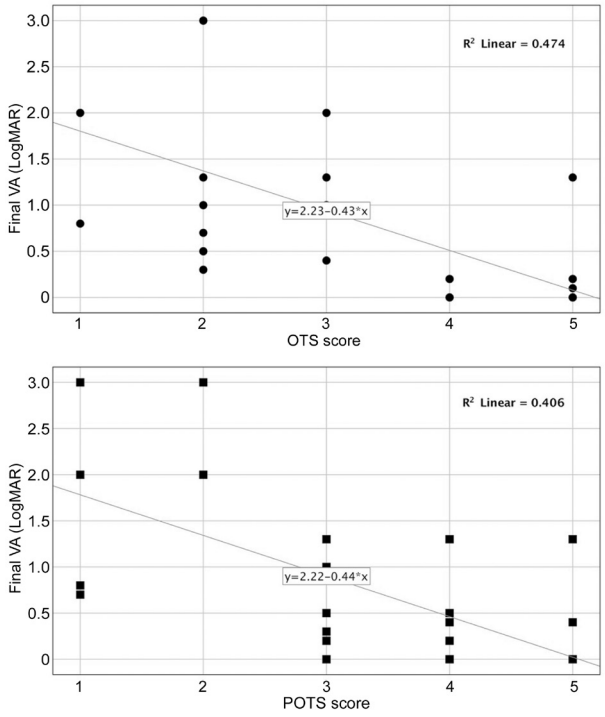

Figure 2 Correlation of OTS, POTS and final visual acuity OTS: Ocular trauma scores; POTS: Pediatric ocular trauma scores.

predictor of final VA ($F_{(1,36)}$=53.737, P<0.001, R^2=0.599). Not only OTS was a significant predictor of final VA ($F_{(1,36)}$=32.408, P<0.001, R^2=0.474), but also POTS ($F_{(1,32)}$=21.876, P<0.001, R^2=0.406); Figure 2). Fifteen (17.9%) patients had improved final VA compared to presenting VA, 19 (22.6%) remained the same and 6 (7.1%) had reduced vision.

Analysis of OTS parameters indicated that initial VA (P<0.001) and globe rupture (P=0.008) predicted worse visual outcome. Using POTS, initial VA (P<0.001), traumatic cataract (P<0.001), organic/unclean wound (P=0.001), delay of surgery (P=0.001), and iris prolapse (P=0.003) had a significant impact on predictive visual outcome. By using Spearman's correlation, we described P-value of each predictive value of OTS and POTS parameter (Tables 3, 4).

Table 3 Predictive value of the evaluated OTS parameters

OTS parameters	n=84 (%)	P
Initial VA		<0.001[a]
NLP	2 (2.4)	
LP-HM	16 (19.0)	
1/200-19/200	7 (8.3)	
20/200-20/50	8 (9.5)	
≥20/40	29 (34.5)	
N/A	22 (26.2)	
Globe rupture	13 (15.5)	0.008[a]
Endophthalmitis	3 (3.6)	0.469
Perforating injury	0	N/A
Retinal detachment	1 (1.2)	N/A
RAPD	6 (7.1)	0.096

[a]Correlation is significant at the 0.01 level. OTS: Ocular trauma scores; VA: Visual acuity; HM: Hand movements; LP: Light perception; NLP: No light perception; N/A: Not available; RAPD: Relative afferent pupillary defect.

DISCUSSION

Ocular trauma is one of major etiologies of monocular and visual impairment in all part of the world and it is widely reported that 90% of ocular trauma are preventable[13-14]. About 20%-59% of all ocular trauma occur in children[12,14]. This is the first study to examine outcomes from globe injuries in Indonesia and provide important information about the predictive value of each scores.

In our study we found a higher proportion of CGI than OGI, a similar pattern was presented in Northern India study[13]. However, Barry *et al*[15] and Madan *et al*[16] presented OGIs were the most common injury. Zone I injuries predominance of both OGI and CGI is consistent to other studies[16-17]. Despite Zone I involvement was common in our population; this finding is important because the visual outcome of children could be affected and often result in amblyopia. None of perforating injuries were found in this study. Our hospital is a private tertiary eye hospital in Jakarta, Indonesia. The documentation variability could be due to vast differences in cultural, social-economic factors and referral services.

A study in central Maharashtra, India[16], reported 6-10 years old children were the mostly affected, whereas in Western Australia[18], 0-2 years old was the highest group who suffered the injuries, these findings differ to our study. In our 11-18 years age group predominance, a child is in the period of adolescence, a transition phase to adulthood, they usually involve in many outdoor activities. A male predominance (7:1) is consistent with previous studies[4,17,19-20]. A possible reason

Table 4 Predictive value of the evaluated POTS parameters

POTS parameters	*n*=84 (%)	*P*
Initial VA		0.001[a]
NLP	2 (2.4)	
LP-HM	13 (15.5)	
CF	7 (8.3)	
0.1-0.5	15 (17.9)	
0.6-1.0	25 (29.7)	
N/A	22 (26.2)	
Age, y		0.772
0-5	18 (21.4)	
6-10	31 (36.9)	
11-15	20 (23.8)	
>15	15 (17.9)	
Wound location		0.025
Zone I	35 (41.7)	
Zone II	25 (29.7)	
Zone III	24 (28.6)	
Iris prolapse	12 (14.3)	0.003[a]
Hyphema	16 (19.0)	0.405
Organic/unclean	24 (28.6)	0.001[a]
Delay of surgery>48h	1 (1.2)	0.001[a]
Traumatic cataract	14 (16.7)	<0.001[a]
Vitreous hemorrhage	6 (7.1)	0.019

[a]Correlation is significant at the 0.01 level. CF: Counting fingers; HM: Hand movements; LP: Light perception; NLP: No light perception; N/A: Not available; POTS: Pediatric ocular trauma scores; VA: Visual acuity.

for this finding could be boys are more involved than girls in daily activities. They are more curious, fearless, and always explore something new.

Calculating OTS Group, we found that OTS 5 (26/62, 41.9%) was predominant, and all of these were CGI's. The 2/62 (3.2%) patients with OTS 1 were due to an OGI. POTS 4 was predominant (18/69, 26.1%) of which 11/18 were due to CGI and 7/18 patients were due to OGI. Good initial VA and a high OTS were statistically correlated with good final VA in our study, and has been identified previously[11,15,21-22]. Madan *et al*[16] demonstrated that OGI present more potential for poor visual outcome than CGI, this presented in this study. According to WHO blindness definition[23], therefore 11 (13.2%) patients in this study would be defined as legally blind.

OTS parameters showed that initial VA (P<0.001) and globe rupture (P=0.008) were highly associated to visual outcome while Schörkhuber *et al*[17] reported initial VA and retinal detachment. POTS parameters showed that initial VA (P<0.001), traumatic cataract (P<0.001) followed by organic/unclean wound (P=0.001), delay of surgery (P=0.001), and iris prolapse (P=0.003) were highly associated with visual outcome. These findings had similar trend in the previous study[17].

OTS was more applicable in all age group as it only required six parameters. In contrast to POTS, we could not calculate our patient with age more than 15 years old into category and it required eleven parameters. Injured children might show poor compliance for initial VA examination. Due to lack of initial VA, we had to eliminate our 22 patients into OTS category, in the other hand, we could calculate all scores of initial VA into POTS category by using POTS equation. Recent study by Awidi and Kraus[10], they had to eliminated seven patients from OTS calculation due to lack of initial VA, therefore POTS to be more predictive of visual outcome than OTS. While Schörkhuber *et al*[17] reported that OTS is reliable prognostic tool for pediatric OGI. Our result indicates that OTS and POTS are accurate to predict final visual outcome, both can be calculated depend on availability of the initial VA and patient's age.

Our study is limited by its retrospective nature, injured children might be quite challenged to determine an accurate history and they could be more uncooperative than adults during the examination (*e.g.* initial VA and slit lamp examination). However, these limitations do not significantly affect the major findings in this study.

In conclusion, this study presents higher incidence of CGI than OGI. Using OTS is more applicable in all age groups than POTS. OTS parameters (initial VA and globe rupture) and POTS parameters (initial VA, traumatic cataract, organic/unclean wound, delay of surgery and iris prolapse) are accurate predictor visual outcome. Both OTS and POTS are highly predictive prognostic tools for closed and open globe injuries in children.

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