

## Role of Ocular Trauma Scores in Predicting Visual Outcome in Children with Open Globe Injuries

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### Abstract:

**Background:** One major factor contributing to vision impairment in children is ocular trauma. Numerous prognostic variables influence these children's visual prognosis. For the purpose of visual prognostication in these children, the two most often used instruments are the Ocular Trauma Score (OTS) and the Paediatric Ocular Trauma Score (POTS). In OTS, initial visual acuity is considered a more significant predictor of visual outcome. But in most cases, children who have experienced recent trauma are not able to have their first visual acuity accurately recorded. The Paediatric Ocular Trauma Score (POTS), a new grading method, was created to get around this.

**Objectives:** To evaluate the effectiveness of Ocular Trauma Score (OTS) and Paediatric Ocular Trauma Score (POTS) in predicting visual outcomes among paediatric open globe injuries.

**Material and Methods:** This retrospective study analysed 58 instances of open globe injuries in children under the age of 15, who were treated at a tertiary eye care hospital in South India from 2014 to 2022. The study participants were categorised into 5 distinct groups according to OTS and POTS criteria. We were unable to allocate the OTS group to 9 children due to the absence of documented initial visual acuity. The achieved visual acuity at 6 months has been compared to the predicted visual acuity using statistical analysis for each group.

**Results:** This research evaluated 58 cases of paediatric open globe injuries. Initial visual acuity (VA), globe rupture, endophthalmitis, and retinal detachment were statistically significant factors in our study for estimating final VA, with p-values of <0.001, 0.001, 0.005, and 0.021 respectively. The analysis of POTS parameters revealed that the initial VA, wound location, retinal detachment, endophthalmitis, and traumatic cataract were significant predictors of final visual acuity with p-values of <0.001, 0.021, 0.021, and <0.001 respectively. An OTS score of  $\geq 86.5$  accurately predicted a satisfactory visual outcome with a sensitivity of 51.7% and specificity of 100% in 49 individuals where OTS computation was feasible. A POTS score of  $\geq 62.5$  accurately predicted the favourable visual outcome with a sensitivity and specificity of 65.7% and 87% respectively, in a sample size of 58.

**Conclusion:** Our research revealed that both OTS and POTS might serve as valuable indicators of the final visual acuity in paediatric open globe injuries. OTS has a more consistent correlation with final visual acuity in higher score groups compared to POTS. We believe that conducting extensive multicentric investigations is necessary to improve the prediction of visual acuity using these trauma scores.

**Key words:** Final visual acuity; Ocular trauma score; Paediatric ocular trauma score; Paediatric open globe injury.

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### Introduction

Ocular trauma is one of the major causes of visual disability in children. It also affects their physical and mental wellbeing and has a high impact on the economic burden of the parents. Among the ocular injuries, open globe injury is the most devastating type. Invariably, most of them need emergency

surgical repair and management of complications. A standardized criterion for visual prognostication is needed for answering the questions regarding the visual outcome in these children. Various scoring systems have been developed and are in use for this purpose. Two regularly utilised scoring systems are

the Ocular Trauma Score (OTS) and the Paediatric Ocular Trauma Score (POTS). [4]

The Ocular Trauma Score [OTS] was developed by Kuhnet et al [5] considering variables like Initial visual acuity (VA), presence of globe rupture, endophthalmitis, perforating injury, retinal detachment (RD) and relative afferent pupillary defect (RAPD). But many a time, it is difficult to assess initial visual acuity and RAPD in a child who has just sustained a trauma. In order to overcome this, Acar et al developed a modified score i.e. Paediatric Ocular Trauma Score [POTS] [4] which downscaled initial visual acuity and removed RAPD from the scoring criteria. In POTS score, there is a supplemental equation for determining the Initial visual acuity in those children where it is not possible to record the Initial visual acuity. There are conflicting reports in the published literature regarding the reliability of these two scores in prognostication of final visual acuity. In this paper we endeavour to compare the efficacy of OTS and POTS in predicting the visual outcome in paediatric open globe injuries.

#### Materials and methods:

##### Ethical Approval:

The study received approval from the Institutional ethics committee of a tertiary eye care institution in South India and adhered to the principles of the

Declaration of Helsinki.

##### Study Procedure:

In this retrospective study, medical records of 58 cases of paediatric open globe injuries which presented to a tertiary eye care centre in South India between 2014 and 2022 were analysed. Patient records were reviewed to collect demographic data, initial VA, details of ocular injury sustained and final VA at 6 months. Children less than 15 years were included in this study. An outcome of visual acuity  $>20/200$  at 6 months was seen as a favourable result. Ocular injuries were categorised according to the Birmingham Eye Trauma Terminology system (BETT). [14]

OTS and POTS scores were assigned to each of the study subjects based on the defined criteria for OTS and POTS. In our study, 9 children did not have recorded initial VA. Hence OTS scoring was not possible in them. For POTS scoring, the equation  $2 \times (\text{age at time of trauma} + \text{location of injury}) - \text{corresponding pathologies}$  was used in those 9 children as described in POTS calculation.

Based on raw score sum, 5 prognostic group are assigned [Table 1]. These prognostic groups are same for both OTS and POTS. The actual final visual acuity attained at 6 months was compared to the predicted final visual acuity for each category using statistical methods.

**Table 1: Predicted Probability of Final visual outcome for both OTS & POTS score categories**

Raw score sum	OTS-POTS score category	NLP (%)	LP/HM (%)	1/200-19/200 (%)	20/200-20/50 (%)	$\geq 20/40$ (%)
0-44	1	73	17	07	02	01
45-65	2	28	26	18	13	15
66-80	3	02	11	15	28	44
81-91	4	01	02	02	21	74
92-100	5	00	01	02	05	92

##### Statistical analysis:

The acquired data was coded and imported into Microsoft Excel, then analysed using the statistical programme SPSS Version 25. Categorical variables have been summarised as percentages.

Qualitative factors were evaluated using Chi-square test as well as Fisher's exact test to determine their correlation. The threshold for statistical significance was established at a p-value of less than 0.05. Jonckhere-terpstra test for ordered alternatives was done to determine the significant trend of OTS and POTS. The final obtained visual acuity (VA) was

compared to the predicted VA for both scores using Kendall's test to determine any significant connection. ROC curve analysis was used to determine the sensitivity and specificity of OTS and POTS scoring.

##### Results:

58 eyes of paediatric patients who had open globe damage were evaluated in this research. All cases included a single eye injury, which was surgically repaired at our facility.

**Table 2: Demographic variables**

Demographic variables		N (%)
Age (in years)	0-5	13 (22.4)
	6-10	20 (34.5)
	11-15	25 (43.1)
Gender	Male	46 (79.3)
	Female	12 (20.7)
Mode of injury	By household objects while playing	42 (72.4)
	Accidental falls	12 (20.7)
	RTA	03 (5.2)
	Reported assault	01 (1.7)
Wound location	Zone 1	40 (69.0)
	Zone 2	14 (24.1)
	Zone 3	04 (6.9)
Concomitant eye pathologies	Iris prolapse	31 (53.4)
	Hyphema	17 (29.3)
	Vitreous haemorrhage	09 (15.5)
	Endophthalmitis	08 (13.8)
	Traumatic cataract	15 (25.8)
	Retinal detachment	04 (6.9)
	RAPD	02 (3.4)

In our study, 9 children did not have recorded initial VA. Hence OTS scoring was not possible in them (N=49).

**Table 3: Raw score and predictive value calculation of OTS parameters (N=49)**

S.No.	Initial visual factors	Raw points	N (%)	P-value	
1.	Initial visual acuity	NLP	60	03 (5.2)	<0.001 (S)
		LP-HM	70	12 (20.7)	
		1/200 to 19/200	80	17 (29.3)	
		20/200 to 20/50	90	11 (19.0)	
		≥20/40	100	06 (10.3)	
		N/A	-	09 (15.5)	
2.	Globe rupture	-23	08 (6.9)	0.021 (S)	
3.	Endophthalmitis	-17	04 (13.8)	0.005(S)	
4.	Perforating Injury	-14	00 (0)	NA	
5.	Retinal detachment	-11	04 (6.9)	0.021(S)	
6.	Relative Afferent Pupillary Defect	-10	02 (3.4)	0.153	

(S) - Statistically Significant

**Table 4: Raw score and predictive value calculation of POTS parameters (N=58)**

S.No.	Initial visual factors	Raw points	N (%)	P-value	
1.	Initial visual acuity	NLP	10	03 (5.2)	<0.001 (S)
		LP-HM	20	12 (20.7)	
		1/200 to 19/200	30	17 (29.3)	
		20/200 to 20/40	40	11 (19.0)	
		>20/40	50	06 (10.3)	
		N/A	-	09 (15.5)	
2.	Age (in years)	0-5	10	13 (22.4)	0.049 (S)
		6-10	15	20 (34.5)	
		11-15	25	25 (43.1)	
3.	Wound location	Zone 1	25	40 (69.0)	0.021 (S)
		Zone 2	15	14 (24.1)	
		Zone 3	10	04 (6.9)	
4.	Concomitant eye pathologies	Iris prolapse	-5	31 (53.4)	0.875
		Hyphema	-5	17 (29.3)	0.458
		Organic/unclean injury	-5	19 (32.8)	0.790
		Delay of surgery >48 h	-5	03 (5.1)	0.556
		Traumatic cataract	-10	15 (25.8)	<0.001 (S)
		Vitreous haemorrhage	-20	09 (15.5)	0.460
		Retinal detachment	-20	04 (6.9)	0.021 (S)
		Endophthalmitis	-30	08 (13.8)	0.005 (S)

(S) - Statistically Significant

**Table 5: Classification of cases into groups as per OTS and POTS criteria**

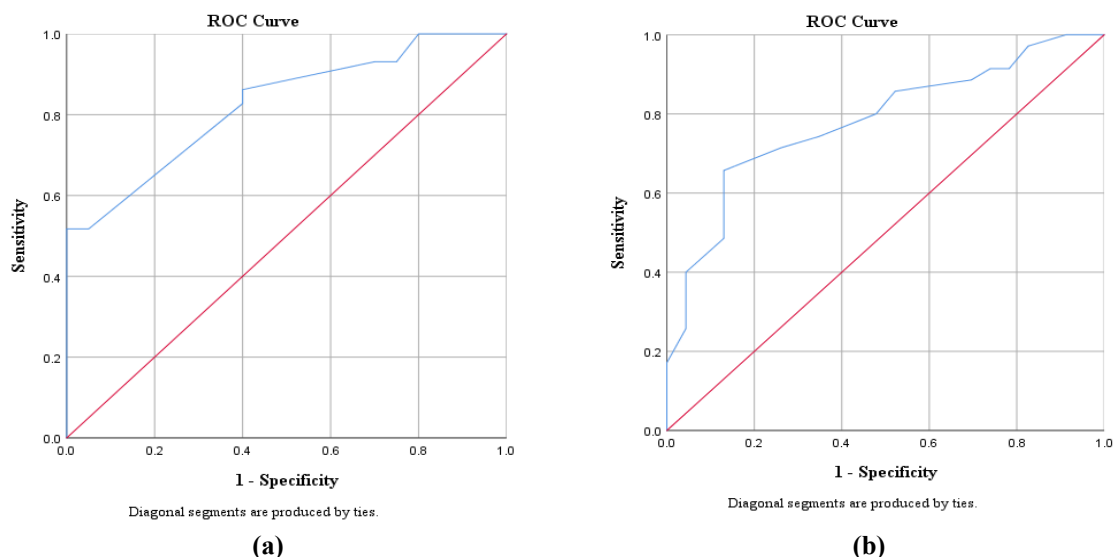
Groups	OTS criteria (N=49)	POTS criteria (N=58)
Group 1	6.10 %	32.80 %
Group 2	10.20 %	22.40 %
Group 3	51.00 %	27.60 %
Group 4	22.40 %	6.90 %
Group 5	10.20 %	10.30 %

The actual final visual acuity obtained by the study subjects in each group as per OTS was determined [Table 6]. A Jonckheere-Terpstra test for ordered alternatives showed that there was a statistically significant trend of higher visual acuity with higher levels of OTS score, TJT=183.50, Z = 4.252, p < 0.001. The actual final visual acuity obtained by the study subjects in each group as per POTS was determined [Table 6]. A Jonckheere-Terpstra test for ordered alternatives showed that there was a statistically significant trend of higher visual acuity with higher levels of POTS score, TJT=356.00, Z = 4.026, p < 0.001.

**Table 6: Distribution of study population based on OTS, POTS score & Final visual outcome**

Groups		Final Visual Acuity					Total
		NLP	LP-HM	1/200 to 19/200	20/200 to 20/40	>20/40	
Group 1	OTS score	3 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3(100%)
	POTS score	3(15.8%)	2 (10.5%)	7 (36.8%)	3 (15.8%)	4 (21.1%)	19 (100%)
Group 2	OTS score	0 (0%)	1 (20.0%)	2 (40.0%)	0 (0%)	2 (40.0%)	5(100%)
	POTS score	0 (0%)	3 (23.1%)	5 (38.5%)	1 (7.7%)	4 (30.8%)	13 (100%)
Group 3	OTS score	0 (0%)	3 (12.0%)	10(40.0%)	6 (24.0%)	6 (24.0%)	25 (100%)
	POTS score	0 (0%)	0 (0%)	2 (12.5%)	8(50.0%)	6 (37.5%)	16 (100%)
Group 4	OTS score	0 (0%)	1 (9.1%)	0 (0%)	2 (18.2%)	8 (72.7%)	11 (100%)
	POTS score	0 (0%)	0 (0%)	1 (25%)	0 (0%)	3 (75.0%)	4 (100%)
Group 5	OTS score	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (100%)	5 (100%)
	POTS score	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6 (100%)	6 (100%)
Total	OTS score	3(6.1%)	5(10.2%)	12(24.5%)	8(16.3%)	21(42.9%)	49(100%)
	POTS score	3(5.2%)	5(8.6%)	15(25.9%)	12(20.7%)	23 (39.7%)	58(100%)

ROC curve analysis for predicting good vision outcome showed an Area Under Curve (AUC) of 0.825 for OTS and 0.781 for POTS. An OTS score  $\geq 86.5$  could correctly predict good visual outcome with a sensitivity of 51.7% and specificity of 100% among those subjects in whom OTS calculation was possible (n=49). On other hand, a POTS score  $\geq 62.5$  could correctly predict good visual outcome with a sensitivity of 65.7% and specificity of 87%.



**Figure 1. ROC Curve for (a) OTS & (b) POTS**

The final VA attained was compared to the predicted VA for each of the scores using Kendall's test to determine any significant connection. The correlation between predicted visual acuity (VA) and actual VA for OTS was determined to be statistically significant (Kendall Tau-b = 0.627, P < 0.001), similarly a significant association was observed between predicted VA and achieved VA for POTS as well (Kendall Tau-b = 0.465, P = 0.002).

**Table 7: Kendall's test for significant association**

OTS/POTS Groups	Kendal Tau-b (Predicted VA and Achieved VA)		Inference
	OTS	POTS	
Group 1 & 2	0.471 (P=0.082)	-0.135 (P=0.590)	Both scores didn't show any significant correlation.
Group 3 & above	0.798 (P<0.001)	0.657 (P=0.002)	Both scores showed a significant positive correlation. However higher correlation was noted for OTS.
Overall	0.627 (P< 0.001)	0.465 (P=0.002)	

**Discussion:**

Ocular trauma is a significant contributor to global blindness. Eye trauma accounts for 7% of all body injuries and 10-15% of all eye disorders. [1] Between 22% and 52% of all eye injuries are believed to happen in youngsters and are a significant reason for monocular blindness in this age range. [2] The leading causes of paediatric ocular injuries are penetrating trauma, blunt trauma, road accidents, and projectile injury. [3,4] Those with penetrating injuries have worse visual prognosis owing to surgeries and more complications. [5,6,7] Communicating to the parents about the visual prognosis is a challenging situation for the treating physician.

Various scales have developed for prognosticating the visual outcome following ocular trauma. Kuhn et al [5] developed ocular trauma score (OTS) to provide a probability estimate that an eye trauma patient would obtain a specific visual range at six months after the injury. [8] It is used for standardizing assessment and visual prognosis in ocular injuries by considering several parameters. Obtaining two criteria in the OTS, visual acuity (VA) and relative afferent pupillary defect (RAPD), can be challenging in children, particularly those who have recently experienced ocular injuries. Acar and colleagues created a paediatric ocular trauma score (POTS) that places less emphasis on initial visual acuity in its predictive model and eliminates the presence of relative afferent pupillary defect (RAPD).[8,9] The updated POTS incorporated patient factors such age and injury location into the scoring system and offered an algorithm to calculate scores in cases when the initial VA was unavailable. There are discrepancies regarding prognosticating the visual outcome in paediatric population. This study aims to identify variables influencing visual prognosis and predict it using OTS and POTS for children hospitalised with open globe damage at a specialised eye care clinic in central Kerala. 58 eyes of paediatric patients who had open globe damage were examined in this research. Majority of our patients were aged above 10 years (43.1%), which correlates with a similar study by Irawati et al. [1] 79.3% of participants were males. [2] Left eye was involved in majority of patients [58.6%]. [3] The patients were grouped into categories as per

OTS and POTS criteria. We were able to assign OTS score to only 49 children among the 58 as we were unable to record initial visual acuity in 9 children. It was seen that majority of children [51%] were in group 3 as per OTS criteria whereas only 27.6% were in Group 3 of POTS.

Among OTS parameters in our study, Initial VA, globe rupture, endophthalmitis and retinal detachment were found to be statistically significant [ $p<0.05$ ] in determining final VA. The highest correlation among these was seen with initial visual acuity [ $p<0.001$ ]. In a Study by Schörkhuber et al, [2] initial VA and RD were the most predictive of final visual outcome [ $p<0.001$ ] Analysis of POTS parameters showed that the initial VA, wound location, retinal detachment, endophthalmitis and traumatic cataract were significant predictors of final VA, of which initial VA and traumatic cataract were most predictive. In a similar study by Chao Xue et al, it was seen that initial visual acuity, age, injury location, traumatic cataract, vitreous haemorrhage, retinal detachment and endophthalmitis were found to be statistically significant factors for the Final visual outcome. [6]

Our study also showed that there was a statistically significant trend of higher visual acuity with higher levels of OTS score and POTS score. This is in accordance with other similar studies also [1]. On comparison, both OTS and POTS had reasonable efficacy in predicting the final visual outcome. By ROC curve analysis, OTS has excellent specificity in higher OTS score categories but the sensitivity was only 51.7%. On the other hand, POTS demonstrated higher sensitivity even in lower POTS score categories. Mehul Shah et al had conducted a similar analysis comparing OTS and POTS in paediatric traumatic cataract and concluded that POTS is a more sensitive and specific score with more accurate predicted outcomes compared to OTS [10]. Acar et al's study found a substantial correlation between the POTS score they developed and the prediction of final VA ( $P<0.001$ ). Awidi et al in their study concluded that POTS maybe superior to OTS in determining the final visual outcome. OTS was found to have a better predictive value in studies by– Schörkhuber et al [2], Rupanshi et al [3], Pahor D et al. [9]

We used Kendall's test to see if there was a significant correlation between the final visual acuity and the predicted visual acuity scores. In Group 3 and higher score categories, there was a notable positive association between OTS and POTS levels. Morgan et al found a strong positive correlation between OTS and achieved VA (Kendall Tau-b = 0.511, P = 0.001), as well as between POTS and achieved VA (Kendall Tau-b = 0.422, P = 0.002), which aligns with our findings. [11]

### Conclusion:

In our study we found that both OTS and POTS may be useful predictors of final VA in paediatric open globe injuries. OTS has a stronger correlation with final visual acuity in higher score categories than POTS. Among OTS parameter, the initial visual acuity and among POTS parameters, the initial visual acuity and traumatic cataract were found to be significant predictors of Final visual Acuity.

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