• Clinical Research •

Application of pediatric ocular trauma score in pediatric open globe injuries

Chao Xue[1], *Li-Chun Yang*[1], *Yi-Chun Kong*[1,2]

[1]Tianjin Eye Hospital, Tianjin Key Laboratory of Ophthalmology and Visual Science, Tianjin Eye Institute; Clinical College of Ophthalmology, Tianjin Medical University, Tianjin 300020, China
[2]Tianjin NanKai Hospital, Tianjin Medical University NanKai Hospital, Nankai University Affiliated Nankai Hospital, Tianjin 300100, China
Co-first authors: Chao Xue and Li-Chun Yang
Correspondence to: Yi-Chun Kong. Tianjin Eye Hospital, Tianjin Eye Institute, Tianjin Key Lab of Ophthalmology and Visual Science; Clinical College of Ophthalmology, Tianjin Medical University; Tianjin NanKai Hospital, Tianjin Medical University NanKai Hospital, Nankai University Affiliated Nankai Hospital, Tianjin 300100, China. kongyc1942@hotmail.com
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Abstract

● **AIM:** To evaluate the predictive value of pediatric penetrating ocular trauma score (POTS) on the visual outcome in children with open globe injury.

● **METHODS:** A retrospective study in 90 children (60 males and 30 females) aged 1-15y (average, 7.48±2.86y) with penetrating ocular trauma was performed. Each patient's POTS was calculated. The effects of POTS on final visual acuity (FVA) were examined. Correlation between factors affecting POTS and the FVA was established.

● **RESULTS:** All patients presented with single-eye trauma. The follow-up time was 3-21mo (average, 10.23±3.54mo). Among the 90 cases of penetrating wounds, 71 eyes (78.89%) were injured in Zone I (wound involvement limited to the cornea, including the corneoscleral limbus), 17 eyes (18.89%) were injured in Zone II (wound involving the sclera and no more posterior than 5 mm from the corneoscleral limbus), and 2 eyes (2.22%) were injured in Zone III (wound involvement posterior to the anterior 5 mm of the sclera). Analysis of POTS and FVA showed important correlation between them (r=0.414, P=0.000). Initial visual acuity (P=0.00), age (P=0.02), injury location (P=0.002), traumatic cataract (P=0.00), vitreous hemorrhage (P=0.027), retinal detachment (P=0.003), and endophthalmitis (P=0.03) were found to be statistically significant factors for the FVA outcome.

● **CONCLUSION:** Ocular trauma presents serious consequences and poor prognosis in children. The POTS may be a reliable prognostic tool in children with open globe injury.

● **KEYWORDS:** the pediatric penetrating ocular trauma score; children; open globe injury; predictive value
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INTRODUCTION

An open-globe injury is defined as a full-thickness laceration of the cornea, sclera, or both[1]. It causes damage to the eyeball structure, resulting in a decline in the vision, and can lead to blindness or eye removal in certain cases.

Ocular traumas are the leading causes of monocular visual disability and monocular blindness in children; they are caused by a number of factors, such as natural hyperactivity and lack of life experience and self-protection awareness[2-3]. The ocular trauma score (OTS), developed by Kuhn *et al*[4], has been widely used as a reliable prediction tool for the visual outcomes after an eye injury[5-12]. However, both the relative afferent pupillary defect (RAPD) and visual acuity (VA) are difficult to evaluate in certain cases in children[13-14]. Acar *et al*[15] proposed a new ocular trauma score system called pediatric penetrating ocular trauma score (POTS) to predict the visual outcome of pediatric penetrating eye injuries. In the present study, we have retrospectively analyzed 5y of clinical data of children with open globe injury to determine whether the POTS have a predictive value on the final visual acuity (FVA) outcome.

SUBJECTS AND METHODS

Ethical Approval The study was approved by the Ethics Committee of Tianjin Eye Hospital, Tianjin Medical University, and adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from all parents of patients (patients and parents of patients) to use their clinical data for analysis and publication.

General Data Data of children with open ocular trauma who were admitted to our hospital for surgery between January 2013 and March 2018 were collected. Inclusion criteria: use of Birmingham eye trauma terminology, as it considers the entire globe as a tissue of reference and includes all types of mechanical eye injury; complete medical records; age≤15y; and hospitalization for surgical treatment.

Scoring Criteria The total score of each factor affecting POTS is presented in Table 1 (A+B+C+D was calculated), and the sub scores of the total score were as follows: POTS-1 (0-45 points); POTS-2 (46-64 points); POTS-3 (65-79 points); POTS-4 (80-89 points); POTS-5 (90-100 points). The following equation was used to determine the trauma score in patients in whom an initial VA was not obtained: 2×(age+zone)−corresponding pathologies.

Statistical Analysis The effects of POTS parameters on the FVA were examined by Wilcoxon Mann-Whitney test and Kruskal-Wallis test. The relationship between the initial and FVA scores was established by using the signed-rank test for paired data. Chi-square test and Spearman Rank Correlation were used to evaluate the predictive value of POTS on the VA outcome after eye injury.

RESULTS

Ninety children (60 males and 30 females) aged 1-15y (average, 7.48±2.86y) were hospitalized with penetrating ocular trauma. All patients presented with single-eye trauma. Follow-up was performed mainly on outpatient visits. The follow-up time was 3-21mo (average, 10.23±3.54mo).

The reported causes of injury were as follows: 21 cases (23.33%) by scissors, 14 cases (15.56%) by pens, 7 cases (7.78%) by glass, 5 cases (5.56%) due to explosions, 5 cases (5.56%) by bamboo sticks, 5 cases (5.56%) by wooden sticks, and 4 cases by toys (4.44%). The remaining 29 cases were affected by other causes. Among the 90 cases of penetrating wounds, 71 eyes (78.89%) were injured in Zone I (wound involvement limited to the cornea, including the corneoscleral limbus), 17 eyes (18.89%) were injured in Zone II (wound involving the sclera and no more posterior than 5 mm from the corneoscleral limbus), and 2 eyes (2.22%) were injured in Zone III (wound involvement posterior to the anterior 5 mm of the sclera). The reported complications associated with open globe injury were as follows: 43 cases of iris prolapse, 27 cases of hyphemia, 7 cases of organic/unclean injury, in 7 cases delay of surgery >48h, 52 cases of traumatic cataract, 3 cases of vitreous hemorrhage, 5 cases of retinal detachment, and 7 cases of endophthalmitis.

The majority of the eyes sustained severe injuries with POTS of 1 (27.78%) and 2 (30%). Of the remaining patients, 20% had a POTS of 3, 16.67% had a POTS of 4, and 5.56% had a POTS of 5.

Table 1 The pediatric penetrating ocular trauma score

Variales	Raw points
A: Initial visual acuity	
NLP	10
LP/HM	20
CF	30
0.1-0.5	40
0.6-1.0	50
B: Age	
0-5	10
6-10	15
11-15	25
C: Wound location	
Zone I	25
Zone II	15
Zone III	10
D: Concomitant eye pathologies	
Iris prolapse	-5
Hyphaema	-5
Organic/unclean injury	-5
Delay of surgery >48h	-5
Traumatic cataract	-10
Vitreous haemorrhage	-20
Retinal detachment	-20
Endophthalmitis	-30

The best-corrected VA at the time of admission and the best-corrected VA at the time of last follow-up are shown in Table 2. At the time of admission, 14.44% of the patients with injured eyes were unable to undergo the VA test. However, all patients were able to undergo the VA test at the last follow-up. The proportion of patients with VA light perception (LP) or hand movement (HM) at admission was 17.78%; this reduced to 3.33% at the last follow-up. The proportion of patients with VA 0.1-0.5 at admission was 38.89%, and it increased to 55.56% at the last follow-up. The proportion of patients with VA 0.6-1.0 at admission was 12.22%, and it increased to 24.44% at the last follow-up. After treatment, the VA of the children improved significantly from that at admission (P=0.000). However, the proportion of patients with VA 0.6-1.0 was still 24.44%.

Correlation analysis between POTS and FVA showed that POTS was significantly correlated with FVA (r=0.414, P=0.000). We analyzed the correlation of various factors affecting POTS and the FVA. The results showed that initial VA, age, wound location, traumatic cataract, vitreous hemorrhage, retinal detachment, and endophthalmitis had a statistically significant correlation with the FVA (Table 3).

DISCUSSION

Children have a high incidence of ocular trauma because of their activeness, curiosity, lack of experience, and self-

Table 2 Comparison of initial visual acuity and visual acuity of last follow-up *n* (%)

VA	IVA	Last follow-up VA
NLP	0	0
LP/HM	16 (17.78)	3 (3.33)
FC	15 (16.67)	15 (16.67)
0.1-0.5	35 (38.89)	50 (55.56)
0.6-1.0	11 (12.22)	22 (24.44)
Noncooperation	13 (14.44)	0

VA: Visual acuity; IVA: Initial visual acuity; NLP: No light perception; LP: Light perception; HM: Hand movement; FC: Counting fingers.

protection consciousness. Statistical data shows that pediatric ocular trauma is the main cause of acquired visual impairment and blindness in children. About 2%-14% of children worldwide suffer from serious visual impairment or even blindness due to eye injury[16-18]. Pediatric ocular traumas do not affect only the child's visual function development, but also the physical and mental health, thus imposing a heavy burden on families and society[19-22]. Penetrating injuries account for up to 50.6% of all pediatric ocular injuries[19-20]. Thus, the provision of timely and appropriate surgical treatment after a penetrating eye injury in particular, is essential for recovery and visual function improvement in pediatric patients. The accurate assessment and prediction of the visual outcome before surgery is of clinical significance.

The OTS was designed by Kuhn *et al*[4] to determine the potential of VA recovery in patients with eye injury. It has become an important tool for the prognosis of visual outcome after ocular trauma. However, some studies[13,15,23] show that it has limited predictive value in pediatric ocular injury. Similar to the RAPD, this methodology is difficult to be accurately applied in children. Acar *et al*[15] improved the OTS and designed the POTS.

Previous studies have shown that POTS is a more sensitive and specific score and is more accurate in predicting outcomes in children, compared to OTS; thus, it is considered a reliable tool to use in pediatric ocular injury with traumatic cataract[24]. POTS is also a reliable prognostic model for evaluating very young children without evaluating initial VA or RAPD; however, it is only used for penetrating eye injuries[14]. In the present study, we retrospectively analyzed the data of children with open ocular trauma in our hospital during the past five years, and observed whether the POTS could predict correctly the VA outcome in children with open ocular trauma.

In this study, the ratio of male to female was 2:1. It is consistent with the results of the study by Nelson *et al*[3] This may be related to the fact that male children are naturally more active, curious and adventurous than girls and lack common sense in life[3,25-26]. Therefore, male children caregivers should be very consistent with safety education, take active protective measures, and be constantly attentive.

Table 3 Analysis of factors influencing visual prognosis

Factors	*n* (%)	*P*
IVA		0.000
NLP	1 (1.33)	
LP/HM	16 (21.33)	
FC	14 (18.67)	
0.1-0.5	34 (45.33)	
0.6-1.0	10 (13.33)	
Age, y		0.020
0-5	22 (25)	
6-10	55 (62.5)	
>10	11 (12.5)	
Wound location		0.002
Zone I	68 (78.16)	
Zone II	17 (19.54)	
Zone III	2 (2.30)	
Concomitant pathologies		
Iris prolapse		0.801
No	48 (54.55)	
Yes	40 (45.45)	
Hyphemia		0.266
No	62 (70.45)	
Yes	26 (29.55)	
Organic/unclean		0.770
No	81 (92.05)	
Yes	7 (7.95)	
Delay of surgery>48h		0.959
No	81 (92.05)	
Yes	7 (7.95)	
Traumatic cataract		0.000
No	36 (40.91)	
Yes	52 (59.09)	
Vitreous hemorrhage		0.027
No	85 (96.59)	
Yes	3 (3.41)	
Retinal detachment		0.003
No	83 (94.32)	
Yes	5 (5.68)	
Endophthalmitis		0.030
No	81 (92.05)	
Yes	7 (7.95)	

IVA: Initial visual acuity; NLP: No light perception; LP: Light perception; HM: Hand movement; FC: Counting fingers.

The study showed that most of the injuries were caused by common daily-life objects, such as scissors, pens, glass, bamboo sticks, *etc*., 52.23% of which are sharp objects. This is consistent with the results of the study by Gupta *et al*[2]. Hence,

caregivers should be mindful of sharp objects, keep them in places inaccessible to children, and never use them as toys, in order to avoid eye injuries.

Our research confirms that the most common injury area in children with ocular trauma was Zone I (78.89%), as reported in earlier studies[27].

In this study correlation analysis showed that POTS and FVA are closely related and eyes with lower POTS had a poorer outcome. We analyzed the correlation factors predictive of poor outcome in POTS and FVA and defined initial VA, age, wound location, traumatic cataract, vitreous hemorrhage, retinal detachment, and endophthalmitis to be statistically significant. IVA was a strong indicator of the FVA as shown in other studies[28-31].

Patient age at the time of injury was another strong predictive factor. Farr *et al*[28] found children aged<4y had worse outcome, as younger children were more susceptible to amblyopia because of the injury. The healing process in children, being different from that in the adults, is associated with intense fibrous tissue proliferation[22], thus making age a strong predictive factor for the FVA outcome.

Shah *et al*[24] found that POTS is a viable tool to predict visual outcomes of pediatric eye injury with traumatic cataract. In the present study, we confirmed that traumatic cataract had a significant relationship with initial VA.

The location of the wound was also found to be a statistically significant prognostic factor. Posterior wounds could have a higher rate of severe damage to the retina and the optic nerve. Research has found that posterior wounds result in higher rates of poor FVA compared to anterior wounds[27,32-33]. Our results confirmed these findings.

Vitreous hemorrhage is related to ocular tissues damage and retinal detachment could lead to photoreceptor cells death. Our results were in accordance with previous findings about the prognostic importance of these two factors[8,27,32,34-35].

Endophthalmitis is another prognostic indicator for the VA outcome[8,34,36]. In our study, 7 of 90 eyes developed endophthalmitis; 1 eye (14.29%) reached an FVA of 20/200, the rest had a poorer FVA of less than 20/200. Thus, we concluded that endophthalmitis was another statistically significant prognostic factor.

There are a few limitations in the present study. The sample size was relatively small, and it was not a multicenter study. However, we consider our study results are of representative significance, as research was done in the largest ophthalmological hospital of the region, which receives the majority of the pediatric open globe injuries.

In conclusion, our study shows that POTS has a reliable prognostic value for the VA outcome in children with open globe injury, even if RAPD and the VA are sometimes difficult to evaluate.

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