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# Comparison of Ocular Trauma Score and Penetrating Ocular Trauma Score in Predicting Visual Outcome in Children

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## ARTICLE INFO

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## ABSTRACT

**Background:** Previously, no standardized system existed for naming and managing ocular trauma. The Ocular Trauma Score (OTS) was introduced to predict visual outcomes in patients with ocular injuries, proving valid in adults. However, its effectiveness in children was uncertain. To address this, the Penetrating Ocular Trauma Score (POTS) was developed specifically for pediatric cases. Despite these advancements, no consensus emerged nationally or internationally on whether OTS or POTS was the superior predictor of visual outcomes in children with ocular injuries.
**Objective:** This study aimed to determine the more reliable scoring system for predicting visual outcomes in children after ocular trauma. A total of 34 patients aged 1 to 12 years with penetrating ocular injuries were included. Consent was obtained from the parents or guardians, and the study's procedure was fully explained. A comprehensive eye examination, covering variables for both OTS and POTS, was conducted at the time of injury, and patients were followed for six months. Results were compared using cross-tabulation with the original OTS and POTS.
**Results:** Of the 34 patients, 23 (67.6%) were male and 11 (32.4%) female, with a mean age of 6.7 years (range 1–15 years). Right-eye injuries occurred in 21 (61.8%) patients, and left-eye injuries in 13 (38.2%). Injuries most frequently occurred at home (61.8%) and in the street (26.5%), with stones (20.6%) and knives (17.6%) as common injury objects. An unclean wound was present in 22 (64.7%) cases, and traumatic cataract developed in 17 (50%) patients. Initial visual acuity (VA) ranged from PL to 20/20 (PL in 47%), while final VA ranged from NPL to 20/20 (PL in 26.5%). OTS results showed variable accuracy in groups 1–3 but matched predictions in groups 4 and 5. For POTS, groups 1, 2, 3, and 5 aligned with expected outcomes.
**Conclusion:** POTS demonstrated higher reliability than OTS in predicting visual outcomes in pediatric ocular trauma cases.

## INTRODUCTION

Vision is very important in our daily life and ocular injury is also common. It is about 13–16% of overall systemic injuries and 83% of total head injuries. In children, the ocular trauma has a different story. A study elucidated that about 25.4 % of ocular injuries occur in children [1]. Globally there were more than 500,000 cases of monocular blindness occurring due to ocular injury, with incidence of 75/100,000 people annually in developing countries [2], [3]. In U.S.A. the incidence of penetrating eye injury was 3.81/100,000 injuries, while

the incidence of open globe injury in Turkey was 3.40 per 100,000 injuries [4]. Hence, the cost of ocular injury was estimated to be 2,357 million dollars per year in Australia. Unfortunately, there is a large number (around 6 million) of children who get ocular trauma every year [5]. Another study investigated that 20-50% of all ocular trauma comprised the pediatric age group [6],[7]. The Ocular injury is a major cause of pediatric blindness, with the age group susceptible for trauma being from 6 to 10 years [8].

Initially there was no standardized system of dealing with patients of ocular trauma. In 1997, "Ocular Trauma Classification System" was proposed. But that was only limited to the zone of injury [9]. A researcher introduced a standardized system of terminology, i.e., the Birmingham Eye Trauma Terminology System (BETTS) [10]. That system proved to be base of the standardization of features of ocular trauma. Afterwards, efforts were made to devise some method for the better management system that can be utilized globally. In this regard, United States Eye Injury Registry (USEIR) introduced the Ocular Trauma Score (OTS), a scoring system to assess patient at presentation [11]. This system gave an estimate of visual prognosis so that the management can be planned accordingly [12]. Initially, OTS found to be very effective. But later on, studies revealed that factors like type, site, size and zone of injury, age of patient, involvement of ocular adnexa and other complications highly affected the visual outcome, but they were not considered in OTS [13-16] As 20–50% of all ocular trauma comprised the pediatric age group, there was a need for a scale that should be suitable for children. There was a tremendously large number (around 6 million) of children who sustain ocular trauma annually [17]. Finally, in 2011, a new scoring system was introduced known as the Penetrating Ocular Trauma Score (POTS) [18]. This system considered the factors affecting the pediatric age group. It included age, site of injury along with other ocular complications, removed RAPD, and gave less weightage to VA [19]. This system was supposed to be better at predicting visual outcomes in kids. So, the rationale of the study is to determine which system is better for predicting ocular trauma in children. Different studies have different results, and no reliable study had been done on the local population, so it was necessary to do this study in Pakistan.

The objective of this study is to determine the more accurate and reliable scoring system for predicting visual outcomes after ocular injury in the pediatric population, specifically comparing the Ocular Trauma Score (OTS) and the Penetrating Ocular Trauma Score (POTS). The hypothesis suggests that the POTS is more reliable than the OTS in forecasting visual prognosis following open globe injuries in children. The study is designed as a comparative longitudinal study, with a duration of 12 months, including a follow-up period of 6 months.

### Sample Size

Sample size of 34 patients was estimated by using 5% level of significance, 90% power of test with expected mean value of Penetrating Ocular Trauma Scale as 100 % and Ocular Trauma Scale as 78.3 %.(20)

n = (Z1-α√(2P(1-P)) + Z1-β√(P1(1-P1) + P2(1-P2)^2)) / (P1-P2)^2

Z1-α = Confidence level 95% = 1.96

Z1-β = Power of test 90%

P 1 = Population proportion 1 = 100%

P2 = Population proportion 2 = 78.3%

$$n = \frac{\{ Z_{1-\alpha}\sqrt{2\,\bar{P}\,(1-\bar{P})} + Z1\text{-}\beta\sqrt{P_1(1-P_1)+P_2(1-P_2)}\}^2}{(P_1-P_2)^2}$$

The sampling technique for this study is non-probability convenient sampling. For sample selection, the inclusion criteria consisted of patients with monocular penetrating eye injuries, children under 15 years of age, and both male and female patients. The exclusion criteria included patients with non-salvageable penetrating eye injuries, any prior ocular interventions, or other ocular pathologies such as infections, inflammation, refractive errors, or amblyopia.

## DATA COLLECTION PROCEDURE

Ethical approval for this study was obtained from the Institutional Review Board (IRB) of King Edward Medical University, Lahore, Pakistan (Annexure A). The confidentiality of all patient records was maintained, with no personal or identifiable information shared. Informed consent, provided in both Urdu and English (Annexures B, C, and D), was obtained from the parents or guardians of all participating patients. The study population was selected from patients presenting to the emergency department of the Institute of Ophthalmology, Mayo Hospital, Lahore, who met the inclusion criteria.

Data collected included the patient's age, gender, the date of injury and hospital admission, the place and object of injury, the time elapsed between the injury and hospital presentation, and the time between presentation and primary surgical repair. Each patient underwent a comprehensive ophthalmic evaluation, which included visual acuity (VA), pupillary examination, slit lamp examination, and fundoscopy. For patients unable to cooperate with the examination, sedation using oral choral hydrate was administered, and evaluations were conducted via direct and indirect ophthalmoscopy.

The specific ocular variables checked and documented for OTS and POTS calculations were wound location, globe rupture or perforation and

presence or absence of endophthalmitis, retinal detachment (RD), afferent pupillary defect, iris prolapse, hyphema, clean/dirty wound, traumatic cataract, and vitreous haemorrhage. OTS and POTS scoring was done for every patient by putting values of corresponding variables in each scoring system. Patients were categorised into 5 groups (from 1 to 5) according to their scores (tables 1 and 2). Group 1 indicates worse prognosis, while group 5 indicates good prognosis.

**Table 1**
*Grouping as per OTS*

| Raw Score Sum of OTS System | OTS Group |
|---|---|
| 0–44 | 1 |
| 45–65 | 2 |
| 66–80 | 3 |
| 81–91 | 4 |
| 92–100 | 5 |

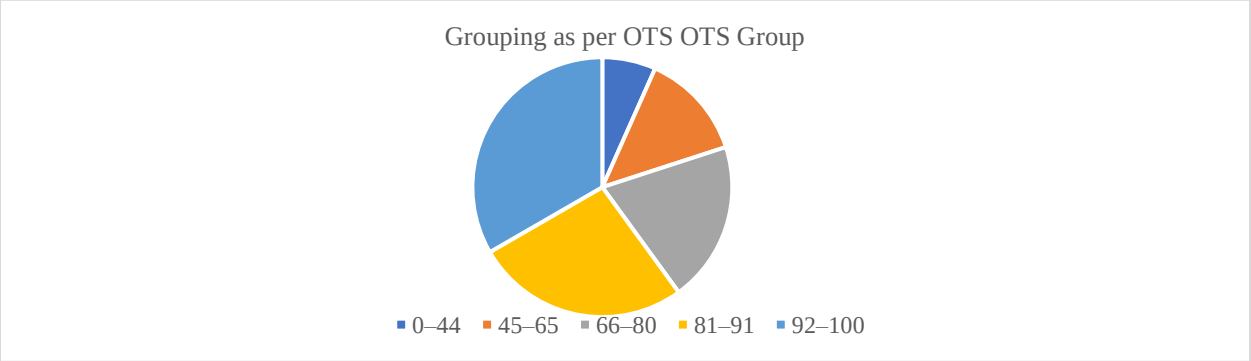
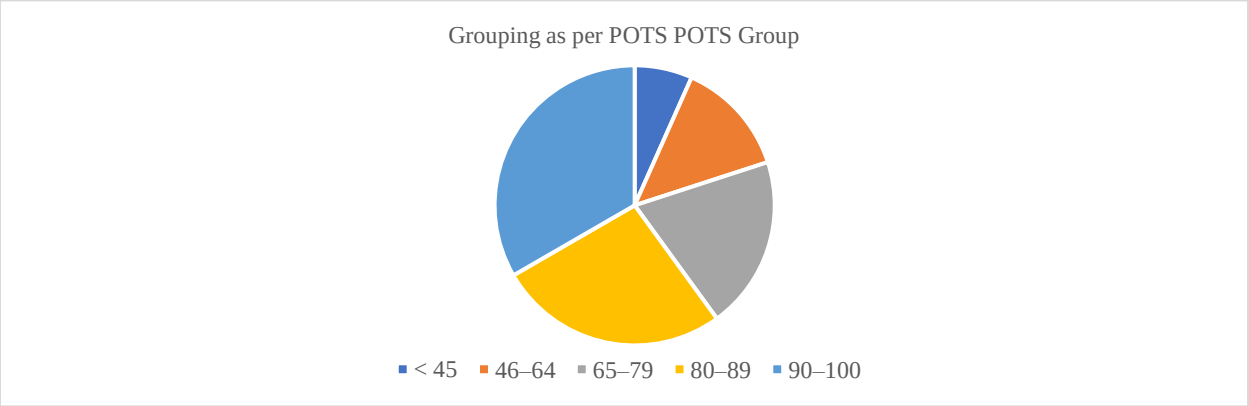



**Table 2**
*Grouping as per POTS*

| Raw Score Sum of POTS System | POTS Group |
|---|---|
| < 45 | 1 |
| 46–64 | 2 |
| 65–79 | 3 |
| 80–89 | 4 |
| 90–100 | 5 |




Follow-up period was 1, 3rd, and 6 months post presentation. The results were compared with the results concluded by the actual OTS and POTS scoring systems (tables 3 and 4)

TABLE 3 : estimated probability of followup \visual acuity at 6 months according ti original OTS RESULTS.

**Table 3**
*Visual Outcomes Based on OTS Grouping*

| Raw Score Sum | OTS Group | NPL (%) | PL/HM (%) | 1/200–19/200 (%) | 20/200–20/50 (%) | ≥ 20/40 (%) |
|---|---|---|---|---|---|---|
| 0–44 | 1 | 73 | 17 | 7 | 2 | 1 |
| 45–65 | 2 | 28 | 26 | 18 | 13 | 15 |
| 66–80 | 3 | 2 | 11 | 15 | 28 | 44 |
| 81–91 | 4 | 1 | 2 | 2 | 21 | 74 |
| 92–100 | 5 | 0 | 1 | 1 | 2 | 92 |

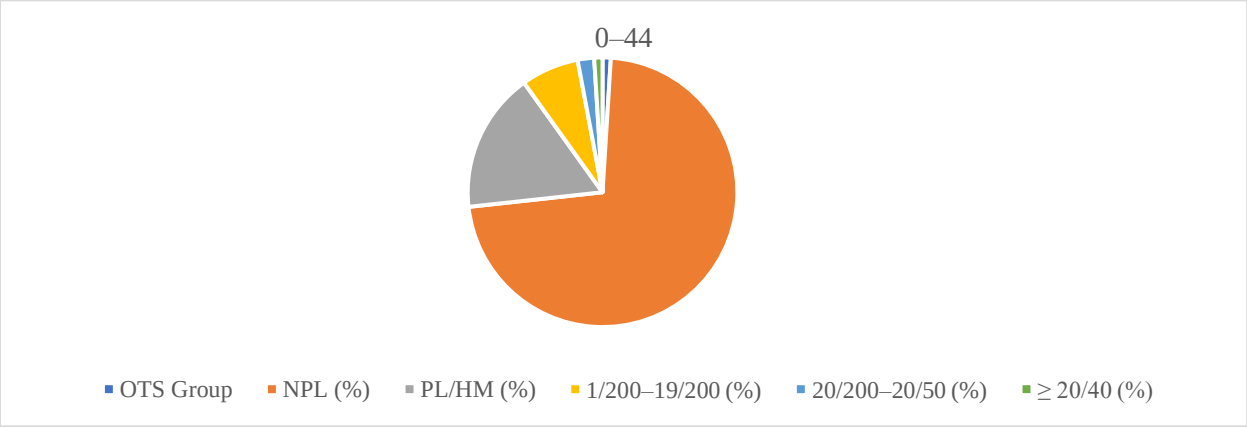



**Table 4**
*Estimated Probability of follow-up Visual Acuity at 6 Months According to Original POTS Results*

| Raw Score Sum | OTS Group | 0–44 (%) | 45–65 (%) | 66–80 (%) | 81–91 (%) | ≥ 92 (%) |
|---|---|---|---|---|---|---|
| 2 | 173 | 21 | 45 | 15 | 13 | 15 |
| 3 | 228 | 18 | 26 | 31 | 15 | 8 |
| 4 | 321 | 28 | 44 | 15 | 8 | 11 |
| 5 | 412 | 21 | 17 | 24 | 21 | 17 |
| 6 | 501 | 29 | 11 | 22 | 22 | 16 |

This table summarizes the raw score sum, OTS group, and corresponding visual outcome percentages.
NPL: No perception of light,
PL: Perception of light,
HM: Hand movements

## RESULTS

All the collected data was entered into SPSS version 26. Quantitative variables like age, time, and VA have been presented as mean +/- SD. Qualitative variables like gender, place of injury, and object of injury have been presented as frequency and percentages. Comparison of the two scoring systems i.e. Penetrating Ocular Trauma Scale and Ocular Trauma Scale has been checked by applying Cross Tabulation method.Total of 34 patients in which 23 were male, whose age was in the range of 1 to 12 years were studied following trauma and their corresponding data was collected. And among those patients no patients were gone for evisceration, enucleation or sympathetic ophthalmia after 6 months or till end of follow up. The age of patients in tabular form (table 5)

**Table 5**
*Age of Patients*

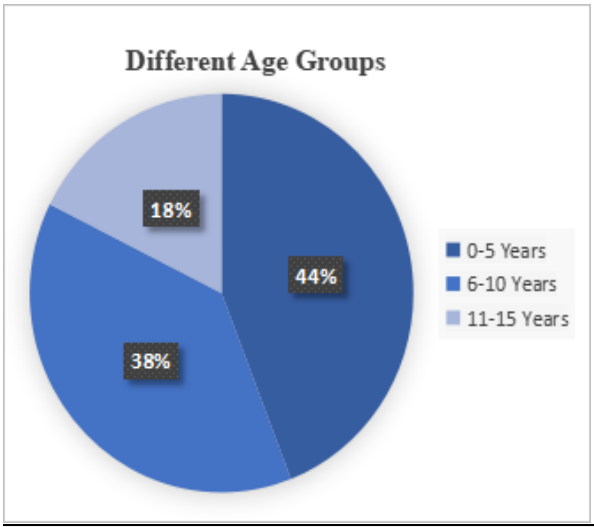
| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Age in years | 34 | 1 | 12 | 6.74 | 2.906 |

Patients were categorized into 3 age groups i.e. less then 5 years, 6-10 years and 11-15 years (table 6). 15 out of 34 (44.1%) patients having trauma were below the age of 5 years while 6 (17.6%) out of 34 patients between 11-15 years had trauma (Figure 1).

**Table 6**
*Patients with Different Age Groups*

| Age Groups | Frequency | Percentage |
|---|---|---|
| <5 Years | 15 | 44.1 |
| 6-10 Years | 13 | 38.2 |
| 11-15 Years | 6 | 17.6 |
| Total | 34 | 100.0 |

**Figure 1**
*Trauma distribution Different Age Groups*

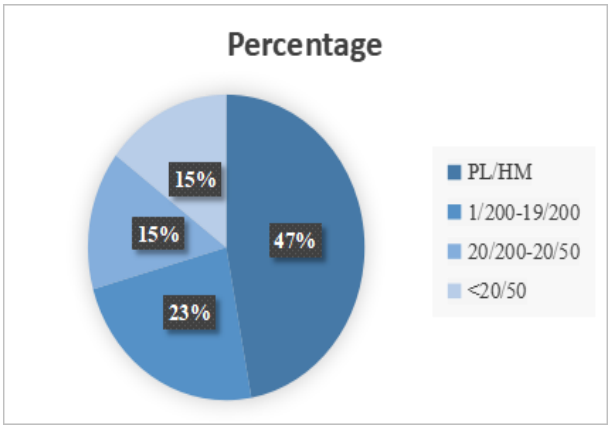



Out of 34 patients, 23 were male depicting that there was a greater probability of male children to get ocular trauma then that of female i.e. 67.6% versus 32.4% .According to findings, 21(61.8%) patients got trauma in right eye whereas rest of the 13(38.2%) had trauma in left eye The common places of injury were ground (2.9%), house (61.8%), school (8.8%) and street (26.5%). The most common being the house with significantly large percentage of 61.8 The time elapsed from injury to presentation of each patient was noted. It had been divided into three groups i.e. early (within 12 hrs.), late (within 24 hrs.), very late (>24 hrs.) It was found that the patients who had presented very late i.e. after more than 24 hours from injury had poorer visual outcome. As mentioned in table 13 patients were PL/NPL who presented very late. In clustered column form it can be easily seen that the patients presented early had good visual outcome and vice versa.The initial VA checked at the time of presentation showed that most of the patients were PL/HM i.e. 16(47.1%). The patients with VA from 1/200- 19/200 were 8(23.5%), with that of 20/200-20/50 were 5(14.7%) and with <20/50 were also 5.

**Table 7**
*Initial VA at the time of Presentation*

| VA | Frequency | Percentage |
|---|---|---|
| PL/HM | 16 | 47.1 |
| 1/200-19/200 | 8 | 23.5 |
| 20/200-20/50 | 5 | 14.7 |
| <20/50 | 5 | 14.7 |
| Total | 34 | 100.00 |

**Figure 2**
*Pie Chart of Initial VA*




The final VA after 6 months including those requiring treatments and any possible required intervention resulted in 9 (26.5%) patients out of 34 to be NPL, 9(26.5%) to be PL/HM, 6(17.6%) had final VA of 1/200-19/200, 4(11.8%) had VA of 20/200-20/50 and 6 of then had VA <20/50. Figure 10

**Table 8**
*Final VA after 6 Months of Presentation*

| VA after 6 months | Frequency | Percentage |
|---|---|---|
| NPL | 9 | 26.5 |
| PL/HM | 9 | 26.5 |
| 1/200-19/200 | 6 | 17.6 |

| | | |
|---|---|---|
| 20/200-20/50 | 4 | 11.8 |
| <20/50 | 6 | 17.6 |
| Total | 34 | 100.0 |

After the ocular trauma, the related ocular findings included 22 (64.7%) unclean injuries, 17 (50%) anterior capsule rupture leading to traumatic cataract, 16 (47.1%) iris prolapse, 7 (20.6%) hyphema, 7 (20.6%) vitreous hemorrhage, 3 (8.8%) endophthalmitis at presentation, 2 (5.9%) Retinal Detachment (Table 9). The delay in surgery (more than 48 ours after injury) was in 14 (41.2%) patients. There was no case of perforation and APD because as per research criteria they were not supposed to be included in study

**Table 9**
*Concomitant Eye Pathologies*

| Ocular pathologies | Frequency | Percentage |
|---|---|---|
| Unclean injury | 22 | 64.7 |
| Traumatic Cataract | 17 | 50.0 |
| Iris Prolapse | 16 | 47.1 |
| Surgery Delay | 14 | 41.2 |
| Hyphema | 7 | 20.6 |
| Vitreous Hemorrhage | 7 | 20.6 |
| Endophthalmitis | 3 | 8.8 |
| Rupture | 2 | 5.9 |
| Retinal Detachment | 2 | 5.9 |
| Perforation | 0 | 0.0 |
| APD | 0 | 0.0 |

After considering the corresponding variables of 34 patients, OTS score of each patient was calculated. All patients fell into 5 groups of the OTS (Table 10). 2 (5.9%) patients categorized in group 1, 8(23.5%) in group 2, 15(44.1%) in group 3, 5 (14.7%) in group 4 and that of 4 (11.8%) in group 5.

**Table 10**
*OTS Grouping*

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 1 | 2 | 5.9 | 5.9 | 5.9 |
| | 2 | 8 | 23.5 | 23.5 | 29.4 |
| | 3 | 15 | 44.1 | 44.1 | 73.5 |
| | 4 | 5 | 14.7 | 14.7 | 88.2 |
| | 5 | 4 | 11.8 | 11.8 | 100.0 |
| | Total | 34 | 100.0 | 100.0 | |

After grouping into 5 categories, patients had been further categorized on the basis of their final VA after 6 months, as per OTS system ). Half of the patients of group 1 had VA in range of 20/200-20/50 while the remaining half had VA equal or better than 20/40.After considering the corresponding variables of 34 patients, POTS score was calculated of each patient. All patients fell into 5 groups of the POTS system as shown in the table no. 16(47.1%) patients categorized in group 1, 11(32.4%) in group 2, 2(5.9%) in group 3, 1(2.9%) in group 4 and that of 4 (11.8%) in group 5. In group 2, majority 05 (63%) of the patients ended up NPL while the remaining 03 (37%) were PL/HM. In group 3, 10(67%) patients were in range of PL/HM to NPL while 05 (33%) were in range of 20/200-20/50. Similarly in group 4, 04(100%) patient lied in range from 20/20-20/200. As far as the last group 5 was concerned, 05 (100%) patients fell in category of VA equal or better than 20/40. After considering the corresponding variables of 34 patients, POTS score was calculated of each patient. All patients fell into 5 groups of the POTS system as shown in the table no. 16(47.1%) patients categorized in group 1, 11(32.4%) in group 2, 2(5.9%) in group 3, 1(2.9%) in group 4 and that of 4 (11.8%) in group 5.

**Table 11**
*POTS Grouping*

| Groups | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| 1 | 16 | 47.1 | 47.1 | 47.1 |
| 2 | 11 | 32.4 | 32.4 | 79.4 |
| 3 | 2 | 5.9 | 5.9 | 85.3 |
| 4 | 1 | 2.9 | 2.9 | 88.2 |
| 5 | 4 | 11.8 | 11.8 | 100.0 |
| Total | 34 | 100.0 | 100.0 | |

After grouping into 5 categories, patients had been further categorized on the basis of their final VA after 6 months, as per POTS system. Half of the patients of group 1 ended up in NPL while the remaining half had VA of PL/HM. In group 2, majority i.e. 07(64%) of the patients had VA within the range of 20/200-20/50 while the remaining 04(36%) were worse than 20/200.

In group 3 half of the patients were in range of 20/200 to 20/50 while the remaining half were equal or better than 20/50. Similarly in group 4 and group 5 100% patients fell in the category of VA equal or better than 20/40.

## DISCUSSION

Ocular trauma is one of the main causes of blindness worldwide. As per world health organization(WHO) every year 55 million people get ocular trauma.[20] The most common reason of acquired monocular blindness in kids is trauma. As kids are more prone to trauma due to less developed motor skills and less awareness about potential hazards in their surroundings. [21] This study was conducted as there was lack of prospective research on ocular trauma in children not only at national but at international level as well. The other purpose of this study was to encourage methods to assess and manage ocular trauma using some standardized systems like BETTS, OTS and POTS, specifically in young children.

Therefore, 34 patients were studied whose age ranges from 1 to 12 years. After distributing these patients in different age groups it was found that most of the patients (44%) who got ocular trauma were less than 5 years of age. And the second highest number is also the younger age group, i.e. from 6-10 years (38%). Likewise in a study done in India, out of total 357 patients of ocular trauma, 271(76%) were less than 12 years of age.(5)So, the less the age of a kid, the more he/she is prone to ocular injury. The age and tendency of injury are directly proportional to each other. More care is needed to be given to younger children.

As far as gender of the patient concerned, in this study male predominance was found i.e. 67% patients were male. This depicts that male children were more likely to get trauma than female due to their more active or aggressive behaviour, habits or games. In addition, they remained involved in more activities as compared to female kids. The laterality of eye to be injured didn't show any specific pattern that a right eye can get injured more than left one and vice versa.

The place of injury always remained an important question as far as safety of kids is concerned. Interestingly, the most common place was found to be "House". 61.8% of the patients got injury while at house. This fact is also supported by Sahraravand A and his fellows in 2018.[22] But it could be a false depiction because most of the time of the young children spent in house. If total time spent in house is compared with time spent on other places, may be results will be different. Second most common place was street i.e. 26.5%. So house and street seemed to be collectively (88.3%) involving most of the patients.

Beside place of injury, object of injury is more important. The most common object in this study was "Stone" comprising 20.6% injuries. Second to stone was knife that resulted in 17.6% of injuries. Unexpectedly house hold broom also caused a lot of injuries i.e. 14.8%. After categorization of all objects into metallic and non-metallic, surprisingly, it was found that more injuries caused by non metallic objects (62%) than metallic ones 38%). So its not only important to keep kids away from sharp metallic objects like knife, scissors etc. but also non metallic objects like stick, rope ,broom etc. should not be in access of children.

The time elapsed from injury to presentation also shown significant results. VA found to be directly proportional to the delay in presentation i.e. the more late the patient presented, more worse was his/her visual outcome. Most of the patients who ended up at VA of HM/PL or NPL was found to be presented very late(after > 24 hours).The reason of late presentation was either unawareness of extent of ocular trauma or the unavailability of ophthalmologist near the home town of the patient. Another reason was the avoidance of any intervention from parents due to lack of medical awareness.The initial VA i.e at the time of presentation, of almost half of the patients (47.1%) was PL or HM. There is a great possibility of error in recording VA of children after trauma. As due to stressful condition and formal atmosphere of hospitals, traumatized children shows lack of cooperation and irritability. And the white coat phenomenon worsens the situation.

The other related factors or pathologies like traumatic cataract, hyphema, iris prolapse etc. that were

not included in OTS were also found to be very important as far as final visual outcome of the patients were concerned. Like patients with unclean injuries (64.7%) got infection later on. That resulted in endophthalmitis, thus poor visual outcome. On the other hand, half of the patients got traumatic cataract. That can directly cause blurred vision or decrease of vision. Even there is delay in its extraction, it would lead to amblyopia.

The final VA of most of the patients were not satisfying. More than half of the patients (53%) had VA worse than CF. Almost 18% patients had VA comparable to normal range. That draws the attention towards ocular trauma and importance of its standardization and thus devising management plans accordingly. So that maximum possible VA of the patients can be saved.

Although OTS had been proved to be effective in predicting VA in adults but that's not the case when patients were young or non cooperating. In this study its was concluded that POTS was a better prognostic tool for assessing and predicting visual outcome of patients of pediatric age in which its difficult to assess initial VA and RAPD.

Ocular trauma can be prevented by paying attention at different levels, first to educate kids not to get involve in potentially harmful activities, next level for parents or care takers to keep sharp and dangerous objects out of reach of children. Because Ocular trauma is associated with a great amount of emotional stress as well as frequent hospital visits and increasing economic burden [23] These type of measures can help in ameliorating the burden not only on affected family but also on health sector [24]. So, ocular trauma is a serious threat, and it has intense effects on vision of the patient. Therefore, timely assessment and management is recommended to prevent additional complications [25]

It's of utmost importance to consider ocular trauma as a serious threat for vision. And to devise and develop efficient ways to manage and predict its outcome. That is only possible if some standard criteria is followed that can be understandable internationally for better coordination.

## Limitations of the Study

The limitations of this study was difficult management of pediatric patients, as it was difficult to assess exact VA of the kids. And most of the times kids after trauma don't let proper ocular examination using slit lamp, indirect ophthalmoscope etc. The delay in presentation after injury had a wide difference but it was not in control of researcher. The primary intervention or the secondary one was done by different surgeons, there was a possibility of biasness.Patients with traumatic cataract and those who didn't develop cataract were not separately considered. Similarly, infected and non-infected patients were not analyzed separately. There was a limited age group in this study, it was better if the results of kids could be compared with that of adults. Due to a limited time to complete this study, samples size was not large enough. And the study done only on the patients of one public hospital, study in different hospitals or even different cities with different demographics could be done.

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