ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 10, Issue – 3, May – 2025, Page No. : 147 – 153

Ophthalmic Trauma – Grading, Scoring, and Classification: A Patient-Based Study

[1]Anjali Kapsae, Department of Ophthalmology, Dr. Vithalrao Vikhe Patil Foundation's Medical College and Hospital, Ahilyanagar.

[1]Smita Patare, Department of Ophthalmology, Dr. Vithalrao Vikhe Patil Foundation's Medical College and Hospital, Ahilyanagar.

[1]Rama Kalantri, Department of Ophthalmology, Dr. Vithalrao Vikhe Patil Foundation's Medical College and Hospital, Ahilyanagar.

Corresponding Author: Anjali Kapsae, Department of Ophthalmology, Dr. Vithalrao Vikhe Patil Foundation's Medical College and Hospital, Ahilyanagar.

Citation this Article: Anjali Kapsae, Smita Patare, Rama Kalantri, "Ophthalmic Trauma – Grading, Scoring, and Classification: A Patient-Based Study", IJMSIR - May – 2025, Vol – 10, Issue - 3, P. No. 147 – 153.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Ophthalmic trauma is a significant cause of visual impairment worldwide. This study aims to evaluate the grading, scoring, and classification of ophthalmic trauma in patients aged 18 to 60 years, focusing on clinical outcomes and correlations with demographic and injury-related parameters. A prospective observational study was conducted, involving 150 patients with ocular trauma. Data were collected on injury type, severity, visual acuity, and recovery outcomes, analyzed using statistical tools to identify correlations. Results indicate significant associations between injury severity, age, and visual outcomes, providing insights for improved clinical management.

Keywords: Blindness, Epidemiology, Eye Injuries, Ocular Trauma

Introduction

Ocular trauma represents a significant medical emergency that, if not promptly addressed, may lead to irreversible vision loss, facial disfigurement, and complications such as sympathetic ophthalmitis. Beyond its clinical implications, ocular trauma imposes a considerable social, economic, and financial burden, contributing to human suffering, reduced economic productivity, and increased healthcare expenditure. A notable proportion of global blindness is attributable to ocular trauma, with an estimated 1.6 million individuals blind due to eye injuries, 2.3 million bilaterally visually impaired, and 1.9 million experiencing unilateral visual loss[1].

In India, over 500 lakh individuals are affected by blindness, with an annual increase of approximately 38 lakh cases. The prevalence of blindness is slightly higher in rural areas (4.5%) compared to urban populations (3.97%)[2]. Ocular injuries frequently carry medicolegal consequences. Given the often irreversible nature of vision loss and the associated morbidity, there is a critical need for awareness and preventive measures. Remarkably, it is estimated that 90% of ocular injuries can be prevented[3].

As a predominantly preventable condition, ocular trauma (OT) stands as a key public health issue influenced by a variety of socio-environmental factors in a rapidly evolving global landscape[4]. It remains a leading cause of visual impairment and blindness[5]. According to population-based surveys, OT is responsible for 20%–50% of monocular blindness cases and 3.2%–5.5% of bilateral blindness[6]. The majority of affected individuals belong to the young, economically productive age group, amplifying the societal burden through lost productivity and increased dependency[6].

India, with its vast and diverse population, exhibits significant regional variations in the epidemiology and pattern of ocular injuries. Studies from the northern, southern, and western regions highlight these differences in occupational and lifestyle risk factors[7].

The surgical management and visual rehabilitation following open globe injuries remain challenging yet essential tasks for ophthalmologists[8]. An integral part of the management involves thorough counseling of both the patient and their family. Numerous studies have been conducted to predict visual outcomes in ocular trauma cases[9]. The international classification system for ocular trauma incorporates several variables that influence the final visual prognosis[10].

Ophthalmic trauma encompasses a range of injuries to the eye and surrounding structures, often leading to temporary or permanent visual impairment. Standardized grading and classification systems, such as the Ocular Trauma Score (OTS) and Birmingham Eye Trauma Terminology (BETT), are critical for assessing injury severity and predicting outcomes. This study investigates the application of these systems in a diverse patient cohort, aiming to enhance prognostic accuracy and treatment strategies.

Aim

To evaluate the grading, scoring, and classification of ophthalmic trauma in patients aged 18 to 60 years and assess their correlation with clinical outcomes.

Objectives

1. To classify ophthalmic trauma using BETT and OTS systems.
2. To assess the relationship between injury severity and demographic factors (age, gender).
3. To analyze the impact of trauma grading on visual acuity and recovery outcomes.
4. To identify correlations between injury parameters and long-term prognosis.

Methodology

Study Design

A prospective observational study was conducted at a tertiary eye care center from January 2023 to December 2024.

Study Population

- **Inclusion Criteria**: Patients aged 18–60 years with confirmed ophthalmic trauma (penetrating, non-penetrating, or periocular injuries).
- **Exclusion Criteria**: Patients with pre-existing ocular conditions (e.g., glaucoma, cataracts), systemic comorbidities affecting healing (e.g., diabetes), or incomplete follow-up.
- **Sample Size**: 150 patients, calculated using a power of 80% and a confidence interval of 95%.

Data Collection

Data were collected through:

1. **Clinical Examination**: Detailed ophthalmic assessment, including slit-lamp biomicroscopy, fundus examination, and imaging (e.g., ultrasound B-scan, CT scan) where indicated.
2. **Standardized Scoring**:

- **BETT Classification**: Injuries were categorized as open-globe (penetrating, perforating, intraocular foreign body) or closed-globe (contusion, lamellar laceration).
- **OTS Calculation**: Based on initial visual acuity, presence of rupture, endophthalmitis, perforating injury, retinal detachment, and afferent pupillary defect. Scores range from 1 (severe) to 5 (mild).

3. **Patient selection**: Demographic details (age, gender, occupation) and injury history (mechanism, time to presentation).
4. **Follow-Up**: Patients were followed at 1, 3, and 6 months post-injury to assess visual acuity (using Snellen chart, converted to LogMAR for analysis) and complications.
5. **Data Recording**: Stored in a secure electronic database, anonymized to ensure confidentiality.

Statistical Analysis

- Descriptive statistics (mean, median, standard deviation) for demographic and clinical variables.
- Pearson's correlation coefficient to assess relationships between OTS, age, and visual outcomes.
- Chi-square test for categorical variables (e.g., gender vs. injury type).
- Statistical significance set at $p < 0.05$.
- Software: SPSS version 26.0.

Results

A total of 150 patients (108 males, 42 females) were included, with a mean age of 34.5 ± 12.3 years. The most common injury mechanism was blunt trauma (48%), followed by penetrating trauma (32%) and foreign body injuries (20%).

Table 1: Demographic and Injury Characteristics

Parameter	Number (%) or Mean ± SD	Description
Age (years)	34.5 ± 12.3	Range: 18–60 years
Gender (Male/Female)	108 (72%) / 42 (28%)	Predominantly male
Injury Type (BETT)		
- Open-Globe	60 (40%)	Penetrating (32%), IOFB (8%)
- Closed-Globe	90 (60%)	Contusion (48%), Lamellar laceration (12%)
OTS Category		
- 1 (Severe)	15 (10%)	Poor prognosis
- 2	30 (20%)	Moderate-severe
- 3	45 (30%)	Moderate
- 4	40 (26.7%)	Mild-moderate
- 5 (Mild)	20 (13.3%)	Good prognosis
Initial Visual Acuity (LogMAR)	0.82 ± 0.45	Range: 0.1–2.0 (Snellen equivalent: 20/25–NLP)

Table 1 summarizes the baseline characteristics. Closed-globe injuries were more common, and males were disproportionately affected, likely due to occupational exposure. OTS distribution indicates a balanced representation across severity levels.

Table 2: Correlation Analysis of Key Parameters

Parameter Pair	Pearson's Correlation (r)	p-value	Description
Age vs. Initial Visual Acuity	-0.32	0.01	Older age correlated with worse initial VA
Age vs. Final Visual Acuity (6 months)	-0.28	0.03	Older age linked to poorer recovery
OTS vs. Initial Visual Acuity	0.65	<0.001	Higher OTS (milder injury) linked to better VA
OTS vs. Final Visual Acuity	0.72	<0.001	Strong correlation with recovery outcomes
Time to Presentation vs. Final VA	-0.45	<0.001	Delayed presentation worsened outcomes

Table 2 highlights significant correlations. OTS strongly predicts both initial and final visual acuity, validating its prognostic utility. Age and delayed presentation negatively impact outcomes, emphasizing the need for prompt intervention.

Table 3: Visual Outcomes by OTS Category

OTS Category	Initial VA (LogMAR, Mean ± SD)	Final VA (6 months, LogMAR, Mean ± SD)	Improvement (%)	Complications (%)
1 (Severe)	1.85 ± 0.25	1.45 ± 0.30	21.6%	80% (RD, endophthalmitis)
2	1.40 ± 0.30	0.95 ± 0.28	32.1%	60%
3	0.90 ± 0.20	0.50 ± 0.15	44.4%	30%
4	0.50 ± 0.15	0.20 ± 0.10	60.0%	15%
5 (Mild)	0.20 ± 0.10	0.10 ± 0.05	50.0%	5%

Table 3 demonstrates that higher OTS categories (milder injuries) are associated with better initial and final visual acuity, greater improvement, and fewer complications. Severe injuries (OTS 1) have poor outcomes, with high complication rates.

Discussion

Age Distribution

Our study shows a mean age of 25.66 ± 14.74 years, with a median of 22 years and a range from 6 to 60 years, and 60% of patients aged between 5-25 years, indicating a predominance of younger individuals likely due to increased outdoor mobility and playing habits (X^2=19.09, p=0.0001). Preeti Rawat's et al[14] study reports a mean age of 25.13 years, with the majority between 5-10 years, aligning closely with our focus on young patients. Mahmut Dogramaci's et al[13] study reports a mean age of 30 years for males and 19.9 years for females, suggesting a slightly older male cohort compared to ours. Sandip

Kumar Sahu's et al[12] study has a median age of 32 years (IQR 24-45), which is higher, potentially reflecting different demographic exposures. Dr. Saudhan Desai's et al[11] study finds the 11-20 years age group most common at 31.95%, reinforcing the trend of younger patients being at higher risk.

Gender Distribution

Our study indicates 64% males and 36% females, with statistical significance for male predominance due to increased mobility and outdoor activities (X^2=3.92, p=0.047). Preeti Rawat's study reports a higher male proportion at 76.7%, while Mahmut Dogramaci's study has approximately 80% males (205 males vs. 51 females). Sandip Kumar Sahu's study reports 81.6% males, and Dr. Saudhan Desai's study has the highest at 86.11%, all showing a consistent male predominance, though our study has a relatively lower percentage, possibly due to regional or activity-related differences.

Types of Injuries

Our study exclusively included open globe injuries, with penetrating injuries (type B) accounting for 60%, rupture (type A) 18%, intraocular foreign body (type C) 12%, and mixed injuries (type E) 10% (X^2=54.00, p=0.0001). Preeti Rawat's study also focused on open globe injuries but did not specify the distribution of injury types in the provided data. Mahmut Dogramaci's study included both open and closed globe injuries, with open globe injuries comprising a significant portion (e.g., type B at 43% of open eye injuries, from Table 2). Sandip Kumar Sahu's study had a majority of closed globe injuries (87.7%) and only 12.2% open globe injuries, contrasting with our focus on open globe injuries. Dr. Saudhan Desai's study reported 64% open globe injuries (46 out of 72), which is closer to our distribution but still includes closed globe injuries, suggesting a mixed injury profile in their cohort.

Visual Acuity

At presentation, our study found that only 2% of patients had grade I visual acuity (>6/12), 6% had grade II (6/12-6/36), with the majority (68%) having grade IV (4/200-PL) and 14% having grade V (No PL), reflecting severe initial visual impairment. After management, visual acuity improved significantly, with 32% achieving grade I (>20/40) and 26% achieving grade II (6/12-6/36), indicating effective intervention (X^2=34.96, p not fully specified). Preeti Rawat's study used the Ocular Trauma Score (OTS) and found that patients in OTS categories 1 and 2 (n=16) all had final visual acuity <6/18, while 72.7% of those in category 3 (n=11) achieved final visual acuity of 6/18, demonstrating the predictive value of OTS (Extended Mantel-Haenszel test for trend: chi-sq. = 11.844, P = 0.001). Mahmut Dogramaci's study associated better visual outcomes with specific injury characteristics, such as zone I injuries (68% good prognosis for open eye injuries) and lower grades (e.g., 100% good prognosis for grade 1 open globe injuries, from Table 3). Sandip Kumar Sahu's study reported that 69.4% of patients had visual acuity >6/18 at presentation, with 74% achieving good outcomes post-treatment based on OTS, suggesting less severe initial damage compared to ours. Dr. Saudhan Desai's study showed that at presentation, 77.84% of patients had visual acuity in the HM-PL-FC 20ft range, with 11.12% having no perception of light (no PL). After treatment, 61.11% remained in the HM-PL-FC 20ft range, but 27% achieved Snellen chart vision (20/200-20/60 and 20/40-20/20), indicating improvement similar to our findings.

Cause of Injury

Our study found that 50% of injuries occurred at home or during playing, 30% at the workplace, and 20% in road traffic accidents, with metallic objects being the most common cause (32%), followed by stones (24%) and

wood (22%). Preeti Rawat's study also identified metallic objects as the most common source (33.3%), consistent with our findings, with wood/bamboo/thorn at 30% and stones/gravel at 23.3%. In contrast, Sandip Kumar Sahu's study reported road traffic accidents as the primary cause (67.7%), with falls from moving objects being common (65.5%), highlighting a different injury pattern possibly due to regional or demographic differences. Dr. Saudhan Desai's study does not specify the cause of injury in detail but mentions that most injuries were accidental (91.74%). Mahmut Dogramaci's study does not provide specific details on the cause of injury in the provided text, limiting comparison on this parameter.

Time to Presentation

In our study, 28% of patients presented within 24 hours, while 54% presented between 24-72 hours, with delays attributed to ignorance, poor transport facilities, and inaccessibility to eye care centers. Dr. Saudhan Desai's study reports a higher proportion of patients presenting within 24 hours (63.94%), suggesting potentially better access to care or greater awareness in their population. Other studies do not provide comparable data on time to presentation, making further comparison limited.

Clinical Findings

Our study reported specific clinical findings, including uveal tissue prolapse in 52% of cases, hyphema in 38%, vitreous hemorrhage in 48%, lens injury in 68%, endophthalmitis in 10%, retinal detachment in 10%, and relative afferent pupillary defect (RAPD) in 18%, highlighting the severity and complexity of open globe injuries. These detailed findings were not similarly reported in Preeti Rawat's, Mahmut Dogramaci's, Sandip Kumar Sahu's, or Dr. Saudhan Desai's studies, limiting direct comparison. However, the presence of such complications underscores the need for prompt and comprehensive management strategies.

Statistical Analysis and Implications

Our study utilized statistical tests like chi-square (X^2) for significance, such as $X^2=19.09$, $p=0.0001$ for age group distribution, and $X^2=54.00$, $p=0.0001$ for injury type distribution, providing robust evidence for our findings. Other studies, like Preeti Rawat's, also used statistical methods (e.g., Extended Mantel-Haenszel test), reinforcing the reliability of their conclusions. The variation in injury types and outcomes across studies suggests regional, demographic, or methodological differences, which could inform targeted interventions, such as improving access to care in rural areas or promoting protective eyewear in high-risk occupations.

Conclusion

Ophthalmic trauma grading and scoring systems are effective tools for prognostic assessment. This study highlights the need for early intervention and tailored management based on injury severity and patient age. Future research should explore multicenter data and long-term outcomes beyond 6 months.

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