



OCULAR TRAUMA: PATTERNS, RISK FACTORS, AND CLINICAL CHARACTERISTICS IN PATIENTS ATTENDING A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Ocular trauma is a major cause of preventable visual impairment worldwide, particularly in developing regions where occupational hazards, low awareness, and limited use of protective measures contribute to a high burden. Understanding local patterns and clinical profiles is essential for improving prevention strategies and optimizing management outcomes.

Objectives: To assess the patterns, risk factors, and clinical characteristics of ocular trauma among patients attending a tertiary care hospital in Udaipur.

Methods: A cross-sectional observational study was conducted in the Department of Ophthalmology at a tertiary care hospital in Udaipur from January to August 2025. A total of 120 patients with ocular trauma were enrolled using consecutive sampling. Data were collected using a structured proforma, including demographic details, mechanism of injury, type of trauma, presenting visual acuity, clinical findings, and management. Ocular trauma was classified using the Birmingham Eye Trauma Terminology System (BETTS). Statistical analysis was performed using SPSS version 26.0. Descriptive and inferential statistics were applied, and p-values <0.05 were considered statistically significant.

Results: The mean age of participants was 32.8 ±14.6 years, with the highest proportion (45%) between 21–40 years. Males constituted 79.2% of cases. Occupational injuries (30%) and domestic accidents (25%) were the most common causes, while only 9.2% reported using protective eyewear. Closed-globe injuries (65.8%) were more frequent than open-globe injuries (34.2%). Common anterior segment findings included corneal abrasion (22.5%), subconjunctival hemorrhage (18.3%), and hyphema (13.3%). Posterior segment involvement was present in 21.7% of cases. Surgical

intervention was required in 30.8% of patients, predominantly among those with open-globe injuries and poor presenting visual acuity.

Conclusion: The study highlights that ocular trauma predominantly affects young working-age males and is largely preventable. Lack of protective measures and delayed hospital presentation remain key contributors to poor visual outcomes. Strengthening occupational safety practices, community awareness, and timely access to eye care services is crucial to reducing the burden of ocular trauma.

Keywords: Ocular trauma, Epidemiology, Risk factors, Visual impairment, Open-globe injury, Occupational hazards.

INTRODUCTION

Ocular trauma is a significant global public health problem, contributing substantially to unilateral blindness, visual disability, and long-term socioeconomic burden. Worldwide estimates suggest that ocular injuries account for approximately 1.6 million cases of blindness and 19 million cases of unilateral visual impairment every year, underscoring its profound impact on vision-related quality of life and productivity [1]. The World Health Organization (WHO) has highlighted ocular trauma as a preventable cause of visual loss, yet its burden remains disproportionately high in low- and middle-income countries where risk exposure is greater and access to timely ophthalmic care is limited [2].

Ocular trauma exhibits considerable variability in epidemiology, mechanism, and clinical presentation depending on environmental, occupational, cultural, and demographic determinants. Males consistently represent the majority of affected individuals, attributed to greater involvement in outdoor activities, industrial occupations, and risk-prone behavior [3]. Previous studies have also identified children and young adults as vulnerable populations due to sports-related injuries, domestic accidents, and unsafe handling of sharp objects [4]. The spectrum of ocular trauma ranges from minor superficial injuries such as corneal abrasions to severe and vision-threatening conditions including globe rupture, intraocular foreign bodies, and traumatic optic neuropathy [5].

Several classification systems have been developed to standardize reporting and guide management, the most widely used being the Birmingham Eye Trauma Terminology System (BETTS), which categorizes injuries as open- or closed-globe based on anatomic integrity [6]. This classification enables uniform documentation and facilitates comparison across studies, thus improving research quality and trauma registry development.

Understanding risk factors associated with ocular trauma is crucial for prevention. Studies have identified occupational hazards, road traffic accidents, agricultural injuries, fireworks, and physical assaults as major contributors, particularly in developing nations [7]. Alcohol consumption, lack of protective eyewear, and inadequate safety regulations further increase vulnerability [8]. Seasonal variations have also been reported, especially during festivals involving fireworks or high-risk activities [9].

The clinical course and prognosis of ocular trauma depend heavily on the mechanism of injury, time to presentation, initial visual acuity, and presence of complications such as hyphema, lens damage, retinal detachment, or endophthalmitis [10]. Early diagnosis with slit-lamp biomicroscopy, ultrasound B-scan, computed tomography, and optical coherence tomography plays a pivotal role in timely intervention and improved outcomes. However, despite advances in diagnostic technology and microsurgical techniques, late presentation and inadequate first aid remain major barriers to optimal outcomes in many regions [11].

The burden of ocular trauma is particularly relevant in India, where diverse occupational structures, dense population, widespread use of hand tools, and limited adherence to protective measures create

a high-risk environment. Studies from various regions of India have reported ocular trauma as a leading cause of preventable ocular morbidity, especially among industrial and agriculture-based workers [12]. Rajasthan, with a mix of rural agricultural population and urbanizing industrial sectors, represents a region where both occupational and domestic trauma risk factors intersect, creating a unique epidemiological profile.

Given these factors, local hospital-based studies are essential to generate context-specific evidence that can inform targeted prevention, policy development, and public health action. They also serve to evaluate clinical trends, outcomes, and gaps in ocular safety awareness. The present study, conducted in the Department of Ophthalmology at a tertiary care hospital in Udaipur intends to contribute to regional data and compare findings with existing literature to support preventive strategies and improved management pathways.

MATERIALS AND METHODS

Study Design: This study was designed as a hospital-based cross-sectional observational study conducted to assess the epidemiological profile, risk factors, and clinical characteristics of patients presenting with ocular trauma.

Study Setting and Duration: The study was carried out in the Department of Ophthalmology at a tertiary care teaching hospital in Udaipur, Rajasthan, India. Data collection was conducted over eight months, from January 2025 to August 2025.

Study Population: The study population comprised patients of all age groups presenting with ocular trauma to the ophthalmology outpatient department (OPD), casualty, or referred from other clinical departments during the study period.

Sample Size: A total of 120 patients meeting the inclusion criteria were recruited consecutively.

Inclusion Criteria

- Patients of any age and gender with a history of ocular trauma.
- Patients presenting with mechanical, thermal, chemical, or radiation-related ocular injury.
- Both new and referred trauma cases during the study period.

Exclusion Criteria

- Patients with non-traumatic ocular pathology mimicking traumatic changes.
- Patients unwilling or unable to provide relevant clinical details.
- Patients lost to follow-up prior to complete clinical evaluation.

Data Collection Tools and Procedure: Data were collected using a structured pretested proforma documenting demographic details, mechanism of injury, type of trauma, affected eye, presenting symptoms, time to presentation, and clinical findings.

All patients underwent:

- Detailed medical and trauma history
- General physical examination
- Comprehensive ophthalmic examination, including:
 - Visual acuity assessment using Snellen's chart or age-appropriate methods
 - Slit-lamp biomicroscopy for assessment of anterior segment structures
 - Intraocular pressure (IOP) measurement using Goldmann applanation tonometry (for closed-globe injuries only)
 - Dilated fundus examination using indirect ophthalmoscopy
 - Seidel's test where corneal or scleral wound leakage was suspected

Additional investigations were performed as indicated:

- Ultrasound B-scan for media opacity or suspected posterior segment injury
- CT scan orbit for suspected open-globe injury, intraocular foreign body, orbital fracture, or optic nerve trauma.

Classification of Trauma: Mechanical ocular trauma was classified according to the Birmingham Eye Trauma Terminology System (BETTS) and Ocular Trauma Classification Group guidelines into:

- Closed-globe injury
 - Contusion
 - Lamellar laceration
- Open-globe injury
 - Rupture
 - Penetrating injury
 - Perforating injury
 - Intraocular foreign body

In addition, chemical injuries were graded based on the Roper-Hall classification system.

Variables Studied: Key variables included

- Demographic factors: age, gender, occupation, residence
- Trauma-related factors: cause, setting, mechanism, laterality, use of protective eyewear, and presence of alcohol consumption at time of injury
- Clinical parameters: presenting visual acuity, anatomical involvement, posterior vs anterior segment involvement, complications, and immediate management given

Outcome Measures

Primary outcomes:

- Pattern and mechanism of ocular trauma
- Clinical spectrum of traumatic ocular injury

Secondary outcomes:

- Association between risk factors and severity of trauma
- Initial visual outcome at presentation

Quality Control Measures All clinical examinations were performed by a trained ophthalmologist, and imaging protocols followed standard departmental guidelines. Data forms were checked daily for completeness and consistency.

Statistical Analysis Data collected during the study were entered and validated in Microsoft Excel and subsequently analyzed using the Statistical Package for the Social Sciences (SPSS) software version 26.0 (IBM Corp., USA). Descriptive statistical methods were used to summarize the data, with categorical variables expressed as frequencies and percentages, and continuous variables summarized as mean and standard deviation (SD). Comparative analysis between categorical variables was performed using the Chi-square test or Fisher's exact test where applicable. Continuous variables were analyzed using the independent t-test or analysis of variance (ANOVA), depending on the normality of data distribution. A p-value of <0.05 was considered statistically significant for all analyses.

Ethical Considerations: Written informed consent was obtained from all adult participants included in the study, while assent and parental or guardian consent were secured for participants below 18 years of age. Participation was voluntary, and no financial or clinical benefit was offered for involvement in the study. Confidentiality and anonymity of patient information were maintained using coded data entry without personal identifiers. All procedures followed the ethical principles outlined in the Declaration of Helsinki, ensuring respect, autonomy, and protection of participants throughout the study.

RESULTS

A total of 120 patients with ocular trauma were included in the study. The mean age of participants was 32.8 ± 14.6 years, with a range of 4 to 78 years. The majority of cases occurred in the age group of 21–40 years (45%), followed by ≤ 20 years (28.3%). Males represented a significantly higher proportion of cases (79.2%) compared to females (20.8%). The right and left eyes were affected almost equally, with bilateral injury documented in 2.5% of cases.(Table 1)

Table 1: Demographic Characteristics and Mode of Presentation (n=120)		
Variable	Category	n (%)
Age Group (years)	≤ 20	34 (28.3)
	21–40	54 (45.0)
	41–60	23 (19.2)
	>60	9 (7.5)
Gender	Male	95 (79.2)
	Female	25 (20.8)
Time to Presentation	<24 hours	72 (60.0)
	24–72 hours	31 (25.8)
	>72 hours	17 (14.2)

Domestic activities (25%), occupational exposure (30%), and road traffic accidents (21.7%) were the most common settings associated with trauma. Only 9.2% of participants reported using protective eyewear at the time of injury. Assault-related injuries accounted for 10% of cases.(Table 2)

Table 2: Distribution of Injury Mechanism and Risk Factors		
Variable	Distribution	n (%)
Mechanism of Injury	Blunt trauma	58 (48.3)
	Penetrating injury	27 (22.5)
	Foreign body injury	21 (17.5)
	Chemical/thermal	14 (11.7)
Context of Injury	Occupational	36 (30.0)
	Domestic	30 (25.0)
	Road Traffic Accident	26 (21.7)
	Sports-related	16 (13.3)
	Assault-related	12 (10.0)

Closed-globe injuries were more commonly observed (65.8%) compared with open-globe injuries (34.2%). Corneal abrasions (22.5%), subconjunctival hemorrhage (18.3%), lid edema and laceration (17.5%), and traumatic hyphema (13.3%) were the most frequent anterior segment findings. Posterior segment involvement was documented in 21.7% of cases, with vitreous hemorrhage and commotio retinae being the most common lesions.(Table 3)

Table 3: Clinical Profile and Injury Classification

Category	Sub-category	n (%)
Type of Injury (BETTS)	Closed-globe	79 (65.8)
	Open-globe	41 (34.2)
Common Findings	Corneal abrasion	27 (22.5)
	Subconjunctival hemorrhage	22 (18.3)
	Lid edema/laceration	21 (17.5)
	Traumatic hyphema	16 (13.3)
	Lens involvement (subluxation/cataract)	10 (8.3)
Posterior Segment Involvement	Present	26 (21.7)
	Absent	94 (78.3)

At presentation, 42.5% of patients had visual acuity worse than 6/60, while 22.5% maintained visual acuity of 6/12 or better. Higher severity of visual impairment was associated with open-globe injuries and posterior segment involvement. Surgical intervention was required in 30.8% of cases, while the remaining patients were managed conservatively. (Table 4)

Table 4: Initial Visual Acuity and Management Approach

Variable	Category	n (%)
Presenting Visual Acuity	≥6/12	27 (22.5)
	<6/12 to ≥6/60	42 (35.0)
	<6/60 – PL+	41 (34.2)
	No perception of light	10 (8.3)
Management Modalities	Conservative (medical)	83 (69.2)
	Surgical intervention	37 (30.8)

No mortality was reported, and most cases required follow-up ranging from one week to three months depending on the severity and intervention required. Late presenters demonstrated a higher likelihood of complications, including secondary infection and persistent visual impairment.

DISCUSSION

Ocular trauma continues to be a major public health challenge worldwide, contributing significantly to preventable visual disability, particularly in developing countries where safety awareness and protective measures remain limited [1,13]. The findings of the present study are consistent with previously published literature, demonstrating that ocular injuries predominantly affect males and younger age groups, especially those aged between 21–40 years, due to their increased involvement in outdoor work and high-risk activities [3,14]. Similar observations were reported by Nirmalan et al. in South India and Soliman et al. in Egypt, reinforcing the global tendency of trauma affecting the productive age group [15,16].

In the present study, occupational exposure, domestic injuries, and road traffic accidents emerged as leading causes of ocular trauma. Comparable findings have been documented in previous studies conducted in India and other low- and middle-income settings where unregulated industrial environments and limited access to protective eyewear increase vulnerability [7,17]. Only 9.2% of patients in this study reported using protective eyewear, reflecting inadequate safety compliance—a trend strongly echoed by earlier reports highlighting similar behavioral patterns among workers and students [8,18].

Closed-globe injuries were more frequently recorded than open-globe injuries in this study, consistent with the literature where blunt trauma accounts for the majority of ocular injuries presenting to emergency services [10,19]. However, despite being less common, open-globe injuries are associated with worse prognosis due to tissue disruption, risk of infection, and need for surgical intervention [5,20]. Corneal abrasion, subconjunctival hemorrhage, lid injuries, and hyphema were among the most common anterior segment findings, which aligns with the spectrum described by the Ocular Trauma Classification Group and large population-based studies [10,21].

Posterior segment involvement was documented in 21.7% of cases, comparable to proportions reported in studies from Andhra Pradesh and Maharashtra, which identified vitreous hemorrhage and retinal contusion as frequent complications [11,12]. Posterior segment injuries are clinically significant due to their strong association with long-term visual morbidity and potential need for advanced imaging and surgical management [19,22]. Initial visual acuity at presentation has been widely recognized as a strong predictor of visual outcome in ocular trauma [10]. In the current study, patients with open-globe injuries and posterior segment involvement demonstrated poorer presenting visual acuity, a finding consistent with international reports demonstrating that delayed presentation and severe mechanism of injury are independent determinants of adverse outcomes [20,23]. Nearly one-third of the patients required surgical intervention, which correlates with published estimates suggesting that 25–45% of ocular trauma cases require operative repair depending on the mechanism and extent of injury [15,24]. The delayed presentation seen in approximately 40% of participants represents a notable challenge affecting visual prognosis. Contributing factors may include lack of awareness, distance from healthcare services, or initial self-treatment practices—issues commonly observed in trauma epidemiology in low-resource settings [22,25]. Strengthening community education, expanding screening, and ensuring timely referral pathways may therefore significantly reduce the burden of visual loss. The overall pattern and epidemiological profile observed in this study align with previously reported findings from similar tertiary care settings, reinforcing the role of local context, occupational patterns, and safety awareness in the burden of ocular injury [12,15]. The results further highlight the urgent need for preventive strategies including mandatory protective eyewear in industrial occupations, public education campaigns, sports safety regulations, and policy-level interventions to improve trauma preparedness and reporting.

CONCLUSION

Ocular trauma remains a significant cause of preventable visual morbidity, particularly among young males engaged in outdoor or occupational activities. In this study, most injuries resulted from blunt trauma and occurred in occupational and domestic settings, with a notable proportion of cases presenting late to the hospital. Closed-globe injuries were more frequent; however, open-globe trauma and posterior segment involvement were associated with poorer presenting visual acuity and an increased need for surgical intervention. The findings align with patterns observed in previous regional and international studies, reinforcing the relevance of ocular trauma as an important public health concern. Limited use of protective eyewear highlights a persistent gap in awareness and safety compliance. Strengthening preventive strategies through education, promotion of safety measures, timely access to care, and enforcement of occupational protection policies is essential to reduce the burden of ocular injuries and improve visual outcomes in affected individuals.

Declarations

Funding: None

Acknowledgements: None

Conflict of Interest: The authors declare no conflict of interest.

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