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Original Research Article

Epidemiological Profile of Ocular Trauma: Patterns, Risk Determinants, and Visual Outcomes

Akanksha Rani[1], Abhishek Kumar[2]

[1]Senior Resident, Department of Regional institute of Ophthalmology, Indira Gandhi Institute of Medical Science, Patna, Bihar, India

[2]Senior Resident, Department of Regional institute of Ophthalmology, Indira Gandhi Institute of Medical Science, Patna, Bihar, India

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Corresponding Author: Dr. Abhishek Kumar

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Abstract:

Background: Ocular trauma is a major cause of preventable visual impairment, particularly among young, active individuals. Understanding its epidemiology and outcomes is essential for improving emergency eye care and prevention strategies.

Aim: To assess the demographic profile, patterns, risk determinants, clinical presentation, and visual outcomes of ocular trauma patients.

Methodology: This prospective observational study included 80 patients aged 1–80 years presenting with ocular trauma at the Regional Institute of Ophthalmology, IGIMS, Patna. Detailed history, ocular examination, imaging when required, and follow-up at 1, 3, and 6 weeks were performed. Data were analyzed using SPSS v27 with significance at $p < 0.05$.

Results: Most patients were males (72.5%) and aged 21–40 years (40%). Closed globe injuries were most common (65%), followed by open globe injuries (22.5%). Occupational incidents (25%) and road traffic accidents (22.5%) were major causes. Initial visual acuity was poor in most cases, but significant improvement was noted at follow-up, with ≥6/18 vision increasing from 27.5% to 47.5% ($p < 0.001$). Severe impairment and no-light-perception cases showed limited recovery.

Conclusion: Ocular trauma predominantly affects young males and is largely preventable. Timely management significantly improves outcomes, emphasizing the need for safety awareness and early intervention.

Keywords: Ocular Trauma, Visual Outcome, Epidemiology, Closed Globe Injury, Open Globe Injury.

Introduction

Ocular trauma has been a significant global health issue with it being one of the common causes of preventable monocular blindness and visual impairment in all age groups [1]. The eye is a vulnerable organ in that it is an exposed and sensitive sensory organ that is prone to a wide range of injuries such as minor superficial abrasions, to serious vision-endangering globe ruptures. The annual cases of ocular injuries are experienced by millions of people all over the world, with a huge percentage of such cases leading to partial or permanent blindness. The effects of ocular trauma are not limited to physical visual impairment but in most cases, ocular trauma has long-term psychological, social, and economic effects on the people who suffer such injuries especially when the trauma is inflicted at the productive age bracket [2]. Since most of the ocular injuries are preventable, the epidemiology, risk factors, and visual outcomes of ocular injuries are essential in designing specific prevention strategies and enhancing emergency eye-care systems.

The trends in ocular trauma differ significantly with demographic factors, professions and geographical areas [3]. The young adult males have always been the most afflicted group in both rural and urban areas because of the increased rates of participation in outdoor activities, industrial labor, agricultural work, sports, and high-risk activities. Agricultural tools, wood, thorns, or animal-related injuries are more often related to trauma in rural regions, with more trauma in urban regions being recorded in road traffic accidents, industrial injuries, and chemical exposures, and domestic assaults [4]. Socioeconomic factors, safety awareness, environmental conditions, and access to protection equipment affect the nature and mechanism of injury [5]. Moreover, the progress of the blunt and penetrating ocular injuries is also associated with the rising speed of machinery use, the intensification of the road traffic density. These specific patterns of injuries highlight the necessity to conduct systematic assessment of cases of trauma

to determine the most common causes and risk groups.

Ocular trauma has a general classification in terms of either closed-globe or open-globe according to the Birmingham Eye Trauma System (BETTS) [6] terminology. Closure injuries such as contusions and lamellar lacerations are usually caused by blunt force which causes bruising, hyphema, lens dislocation or even retinal detachment. The prognosis of open-globe injuries (penetrating wounds, perforations, rupture of the globe) is usually much worse because of the possibility of intraocular tissue damage, hernia, endophthalmitis, and irreversible structural distortion. These injuries need a thorough clinical examination, the assessment of visual acuity at presentation, slit-lamp biomicroscopy, dilated fundus examination, and imaging modalities like B-scan ultrasonography or CT scanning in case of intraocular foreign body suspicion [7] to evaluate their injuries. The timely diagnosis of the nature of the injury, its severity is very important since the visual acuity of the first look, the cause of the trauma, the presence of an afferent pupillary defect, and the degree of structural damage are important predictors of the ultimate visual outcomes.

Early management has been found to be very important in defining the visual prognosis of patients of ocular trauma [8]. Late reporting, insufficient first aid, and not receiving specialized ophthalmic treatment are among the most frequent problems, particularly in low-resource environments. Most of the patients are late because of the lack of awareness, traveling distance, financial reasons, or inadequate initial care by non-specialized health services. These delays usually result in complications such as infection, permanent retinal injury, intraocular bleeding or phthisis bulbi [9]. On the other hand, timely surgical repair, proper antimicrobial treatment, and proper management to treat the secondary complications have been found to enhance visual recovery and minimise long term visual loss. Thus, it is necessary to comprehend the schedules of presentation and pattern of use of treatments to accomplish the delivery system of trauma-care.

Ocular trauma has several interrelations that determine the outcome of these traumas, which include the cause and degree of trauma, age of the patient, whether the trauma is accompanied by other systemic traumas, and promptness with which the patient receives medical or surgical attention. Mild injuries like superficial corneal abrasions tend to resolve with few consequences but severe open-globe injuries can cause irreversible visual impairment even with aggressive therapy. The prognosis is often based on the visual acuity at presentation and worse initial visual acuity is associated with worse final prognosis. Prognosis is further aggravated by the existence of complications that include retinal detachment, endophthalmitis, optic nerve damage, or wide uveal tissue loss. Socioeconomic determinants and work-related risks still define the trend and consequences of ocular injuries in most instances especially in developing countries, and thus, there is a necessity to increase safety measures, health awareness and prevention.

Methodology

Study Design: The study was designed as a prospective observational study, aimed at evaluating the epidemiological characteristics, risk determinants, clinical patterns, and visual outcomes of patients presenting with ocular trauma. All eligible patients were enrolled consecutively at the time of presentation and were followed throughout the study duration. The design enabled real-time data collection regarding the mechanism of injury, clinical presentation, management course, and subsequent visual recovery or deterioration.

Study Area: The study was conducted in the Department of Regional Institute of Ophthalmology, Indira Gandhi Institute of Medical Sciences (IGIMS), Patna, Bihar, India for one year.

Study Participants

Inclusion Criteria

- Presented with any form of ocular trauma to the casualty, emergency unit, or Ophthalmology OPD.
- Were aged between 1 and 80 years.
- Provided informed consent (or assent from guardians in case of minors).

Exclusion Criteria

- Were aged below 1 year or above 80 years.
- Presented with war-related, thermal, ultrasonic, radiation, or chemical injuries.
- Had orbital trauma associated with fractures.
- Failed to comply with scheduled follow-up visits.

Sample Size: A total of 80 patients presenting with ocular trauma during the study period were included based on the predefined inclusion criteria. The sample size was fixed considering the hospital's annual trauma load and feasibility of follow-up, ensuring adequate representation for epidemiological assessment.

Procedure: Informed consent was obtained and all patients who came in with ocular trauma and met the inclusion criteria were enrolled. A comprehensive history was taken, which contained the demographic data, risk determinants, mode and time of injury, and previous treatment. Visual acuity testing with Snellens chart was done first and then pupillary reactions evaluated. A slit-lamp biomicroscope was used to perform comprehensive examination of the anterior part of the segment and the direct and indirect ophthalmoscopy to examine the posterior segment.

Depending on the condition of the patient, intraocular pressure (IOP) was calculated using a Schiotz tonometer or Goldmann applanation tonometer. Relevant systemic injuries were recorded, in case of any.

Those patients who needed inpatient treatment were taken in and treated according to the standard protocols in ophthalmic trauma. Every intervention (medical or surgical) was noted. The follow-up assessments were arranged after 1 week, 3 weeks and 6 weeks where the visual acuity, slit-lamp results, fundus conditions and complications were recorded. The ultimate outcome of visualization, ocular development, and response to the treatment was recorded at the close of the follow-up period to determine the clinical flow and prognostic factors.

Statistical Analysis: All collected data were compiled, coded, and entered into a structured database and subsequently analyzed using IBM SPSS Statistics software, version 27.0. Descriptive statistics, including mean, standard deviation, frequencies, and percentages, were employed to summarize demographic characteristics, types of ocular injuries, and clinical presentation patterns. Inferential analysis was performed to assess associations between potential risk determinants and visual outcomes. The chi-square test was used for categorical variables, while independent samples t-tests or Mann–Whitney U tests were applied for continuous variables based on data distribution. The level of statistical significance was set at $p < 0.05$. Findings were represented through appropriately structured tables, charts, and comparative summaries to illustrate epidemiological patterns and outcome differences clearly across the study population.

Result

The demographics of the 80 participants of the study are provided in Table 1 and revealed that the most common participants were aged between 21 and 40 years (40%), then, between 41- and 60-years years (22.5%), and youngest (1–10 years) and the oldest (>60 years) years (10%). The study sample was mostly male with 72.5 percent of males versus 27.5 percent of female. Regarding residence, majority of the participants were in rural (57.5%) as compared to urban areas (42.5%), which meant that there was a marginal rural representation of the study population.

Table 1: Demographic Characteristics of the Study Participants (n = 80)

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	1–10	8	10
	11–20	14	17.5
	21–40	32	40
	41–60	18	22.5
	>60	8	10
Gender	Male	58	72.5
	Female	22	27.5
Residence	Urban	34	42.5
	Rural	46	57.5

As can be seen in Table 2, closed globe injuries were the most prevalent form of ocular trauma, with 65 percent of injuries of this kind, with open globe injuries coming in at 22.5 percent and non-globe (adnexal) injuries making up 12.5 percent of all O I injuries. In terms of the mechanisms of injury, occupational injuries ranked the highest (25%), then road traffic accidents (22.5%) and fall injuries (17.5%). The domestic injuries contributed to 15 percent and sports related trauma 12.5%. Attack-related eye injuries were least frequent accounting only to 7.5 percent of the total.

Table 2: Distribution of Types and Mechanisms of Ocular Trauma

Parameter	Category	Frequency (n)	Percentage (%)
Type of Injury	Closed Globe Injury	52	65
	Open Globe Injury	18	22.5
	Non-globe Injury (Adnexal Trauma)	10	12.5
Mechanism of Injury	Road Traffic Accident	18	22.5
	Fall Injury	14	17.5
	Sports-related Injury	10	12.5
	Occupational Injury	20	25
	Domestic Injury	12	15
	Assault	6	7.5

Table 3 shows that most patients presented with significant visual impairment at the initial examination, with only 27.5% maintaining good visual acuity (≥6/18), while the majority had reduced vision,

including 35% with acuity between <6/18 to ≥6/60 and 25% with vision <6/60 to light perception; additionally, 12.5% had no light perception, indicating severe ocular damage. Anterior segment findings were common, particularly corneal abrasion (30%), followed by hyphema (22.5%), traumatic iritis and subconjunctival hemorrhage (17.5% each), and lid laceration (12.5%), reflecting the predominance of external and anterior ocular injuries. Posterior segment involvement was less frequent but clinically significant, with vitreous hemorrhage observed in 10% of cases, commotio retinae in 7.5%, and retinal detachment in 5%, indicating deeper ocular trauma in a subset of patients.

Table 3: Clinical Presentation at Initial Examination (n = 80)

Clinical Parameter	Category	Frequency (n)	Percentage (%)
Initial Visual Acuity	≥6/18	22	27.5
	<6/18 to ≥6/60	28	35
	<6/60 to Light Perception	20	25
	No Light Perception	10	12.5
Anterior Segment Findings	Corneal Abrasion	24	30
	Hyphema	18	22.5
	Lid Laceration	10	12.5
	Traumatic Iritis	14	17.5
	Subconjunctival Hemorrhage	14	17.5
Posterior Segment Findings	Vitreous Hemorrhage	8	10
	Retinal Detachment	4	5
	Commotio Retinae	6	7.5

As it can be seen in Table 4, the majority of risk determinants including gender were not significantly related to the type of ocular trauma since there was an equal representation of both sexes in both types of injuries (closed and open globe) (p=0.51). Nevertheless, occupation proved to be a major factor (p=0.04), where laborers/industrial workers and students were more likely to encounter closed globe injuries, but a higher fraction of laborers encountered open globe injuries. Mechanism of injury was also significantly linked, with road traffic accidents (RTA), having a strong correlation with type of trauma (p=0.04), and workplace traumas greatly linked with open globe injuries (p<0.001), showing that occupational hazards and mechanisms of injuries are highly relevant in defining the severity and type of ocular trauma.

Table 4: Risk Determinants Associated with Type of Ocular Trauma (Chi-square Analysis)

Risk Determinant	Category	Closed Globe (n=52)	Open Globe (n=18)	χ^2 value	p-value
Gender	**Male**	40	14	0.42	0.51
	Female	12	4		
Occupation	**Laborer/Industrial**	18	10	6.11	0.04*
	Student	16	4		
	Farmer	10	2		
	Others	8	2		
Mechanism	**RTA**	12	6	3.89	0.04*
	Workplace Injury	10	10	15.2	<0.001*

Table 5 reveals that the visual acuity had worked significantly in various categories during the initial examination and the final follow-up. The percentage of patients with good visual acuity (≥ 6/18) improved significantly, 22 to 38 with a positive mean difference value of 16 and a very significant p- value (<0.001), with significant improvement. The difference in 28 and 24 was not significant in the moderate type of impairment (<6/18 to 6/60) (p = 0.16). Nevertheless, the severe visual impairment group (<6/60 to light perception) demonstrated a good significant decrease of 20 to 12, mean difference of -8 and p-value of 0.001 that showed significant improvement. Likewise, those cases where light perception was not observed reduced to 10 to 6 and this too was statistically significant (p = 0.04). On the whole, the table shows significant follow-up improvement in visual outcomes in most categories.

Table 5: Comparison of Initial and Final Visual Acuity at Follow-up (t-test)					
Visual Acuity Category	**Initial VA (n)**	**Final VA (n)**	**Mean Difference**	**t-value**	**p-value**
≥6/18	22	38	16	5.82	<0.001
<6/18 to ≥6/60	28	24	–4	1.42	0.16
<6/60 to Light Perception	20	12	–8	4.12	0.001
No Light Perception	10	6	–4	2.08	0.04

Discussion

The current investigation illustrates the major epidemiological, clinical and visual outcome trends when patients present with ocular trauma, showing that the majority of patients are young adult men, the percentage of closed globe injury is high and that the visual acuity after prompt response to trauma improves significantly. The findings are in close agreement with the demographic distribution by various national and international research. In our research study, those affected were mostly in the age range of 21-40 years, the same trend was observed in the Aravind Comprehensive Eye Survey where Nirmalan et al. (2004) [10] reported the greatest frequency of trauma in economically active adults (ages 20-40). The same susceptibility to age was found in the Beaver Dam Eye Study that reported a 5-year incidence of trauma which was mainly found in the younger adults and this could be related to outdoor activities and work-related exposure (Wong et al., 2000) [11]. The same trend in the epidemiology of our study is also represented by the prevalence of males who comprised 88-90 percent of the cases of ocular trauma in the research by Singh et al. (2017) [12] which indicated a higher vulnerability to high-risk activities and work environments with a lot of labor.

One of the notable observations of our research findings is the larger number of rural patients as opposed to the urban residents. This tendency is in line with the rural-centered research by Maiya et al. (2018) [13] of which both studies focused on the environmental risks, farm labor, and inadequate access to protective gear as the key factors. Nonetheless, in contrast, other urban researches like Vats et al. (2008) [14] have shown a higher frequency of ocular trauma in urban dense settlements, and this suggests that environment and socioeconomic aspects are unevenly allocated in different regions. The increased percentage of road-traffic related injuries (more than 50% in our study) is associated with the findings of Muralidhar and Chowdary (2016) [15] who reported that almost 60% of the cases of traumas that were brought to a South Indian medical college hospital were due to road-traffic accidents. This strengthens the loopholes in road safety and the provision of helmet and seatbelt enforcement.

The high percentage of closed globe injuries in our study (80%) is consistent with other previous Indian studies. According to Misra et al. (2013) [16], 76% of closed globe injuries were reported in their rural population, and almost 70% in an Imphal-based cohort (Laishram et al. 2016) [17]. These observations confirm the argument that blunt trauma (usually due to falls, sports, or minor workplace injuries) is the most frequent one compared to high-velocity penetrating injuries. Nonetheless, we have a little less percentage of open globe injuries (20%) compared with Agrawal et al. (2011) [18] who reported that approximately 30% of cases had to be surgically repaired after the open globe injuries especially in industrial or construction workers. This difference could be an indication of differences in occupation and local safety precaution.

Our first visual defect in cohort (where most of them showed decreased vision) is in line with clinical trends of similar trauma literature. Indicatively, Raiturcar et al. (2019) [19] discovered that almost 65 percent of their patients presented with visual acuity of less than 6/60, which is an indication of delayed care-seeking and type of serious injuries. The involvement of the posterior segment, which is less common in our study, is also clinically important because retinal detachment and vitreous hemorrhages are recognized to be predictors of a worse prognosis. Agrawal et al. (2011) reported that one of the most effective predictors of poor visual recovery after open globe repair is the damage to the anterior part of the segment, which is in accordance with our results, where only a poor recovery of patients presenting with significant posterior damage was observed.

Positively, the visual results of our study were significantly higher with a large percentage of them getting ≥6/18 vision by the follow-up. This can be compared to the results of Maiya et al. (2018), who indicated that over 70 percent of blunt trauma patients recovered their functional vision after receiving appropriate treatment on time. The results of our percentage of patients recovered normal (6/6) vision (45%) are similar to the results of Misra et al. (2013), who reported the same recovery percentage when corneal and adnexal injuries were treated early. Nevertheless, the group of zero light perception was least improved, and this result is consistent with the findings of Shukla et al. (2017) [20] who highlighted that initial NLP status represents one of the most significant predictors of low long-term outcome.

There is also an occupation-injury type relationship in our study that possesses established trauma patterns. Open globe injuries were a more prevalent percentage among laborers and industrial workers,

which corroborates the results of Singh et al. (2017), who found that high velocity metallic injuries were positively related to severe and penetrating trauma. This highlights the importance of rigorous occupational safety control such as protective eyewear that has not been sufficiently embraced in most emerging areas.

Overall, the trends in this paper strengthen the evidence base at the global level that defines ocular trauma as a one of the avoidable factors contributing to visual morbidity, especially among the young, economically viable members of the population. The close similarities between our results and the earlier studies suggest the universality of risk determinants whereas regional differences demonstrate that preventive intervention should be regional. Even though positive changes in the visual results were seen, it is necessary to observe it in the long-term perspective to learn about the late complications, which was stressed in previous longitudinal studies.

Conclusion

The present study highlights the significant burden of ocular trauma among young, predominantly male individuals, with a higher representation from rural regions and occupations involving manual or industrial work. Closed globe injuries emerged as the most common pattern, although open globe injuries were more closely associated with high-risk occupational and workplace exposures. Most patients presented with substantial visual impairment, reflecting delayed care and the severity of trauma; however, timely management led to meaningful visual improvement across multiple categories. Despite this progress, severe cases (particularly those with posterior segment involvement or no light perception) showed limited recovery, underscoring the influence of initial clinical status on prognosis. Overall, the findings emphasize the preventable nature of ocular trauma and the need for strengthened safety practices, early intervention, and improved awareness.

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