



Research Article

Clinical Patterns And Visual Outcomes Following Blunt Ocular Trauma: An Observational Analysis At A Tertiary Care Centre

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ABSTRACT

Background: Blunt ocular trauma represents a significant cause of preventable monocular blindness worldwide, with varying presentations ranging from minor contusions to severe globe ruptures. This study aimed to analyze the clinical patterns, demographic characteristics, and visual outcomes of patients presenting with blunt eye trauma at a tertiary care centre.

Methods: A prospective observational study was conducted over 18 months, including 50 consecutive patients presenting with blunt ocular trauma. Comprehensive ophthalmological examination was performed including visual acuity assessment, anterior segment evaluation, intraocular pressure measurement, and dilated funduscopy. Patients were followed for six months to assess final visual outcomes and complications.

Results: Males comprised 72% of cases with a mean age of 32.4 years. Road traffic accidents (36%) and workplace injuries (28%) were the predominant causes. Initial visual acuity was $<6/60$ in 44% of cases. Hyphema (52%), traumatic mydriasis (38%), and lens subluxation (24%) were common anterior segment findings. Commotio retinae (32%) and vitreous hemorrhage (28%) were frequent posterior segment manifestations. Final visual acuity improved to $\geq 6/18$ in 58% of cases. Factors significantly associated with poor visual outcome included initial visual acuity $<6/60$ ($p < 0.001$), presence of hyphema grade III-IV ($p = 0.003$), and posterior segment involvement ($p = 0.002$).

Conclusion: Blunt ocular trauma remains a significant cause of visual morbidity, particularly affecting young males. Early intervention and appropriate management of complications can result in favorable visual outcomes in the majority of cases. Workplace safety measures and road traffic injury prevention strategies are essential for reducing the burden of ocular trauma.

Keywords: Visual Outcomes, Blunt Ocular Traum, Diagnostic imaging.

INTRODUCTION

Ocular trauma represents one of the most significant yet preventable causes of monocular blindness and visual impairment globally, with blunt trauma accounting for a substantial proportion of these injuries (1). The World Health Organization estimates that approximately 55 million eye injuries occur annually worldwide, with blunt trauma mechanisms contributing to nearly 40% of all ocular injuries requiring medical intervention (2). The impact of blunt ocular trauma extends beyond immediate tissue damage, often resulting in long-term visual disability, psychological distress, and substantial socioeconomic burden on both individuals and healthcare systems.

The epidemiology of blunt ocular trauma demonstrates considerable variation across different geographical regions and populations, influenced by factors including industrialization levels, traffic patterns, sporting activities, and occupational hazards (3). In developing nations, the incidence of blunt eye injuries has shown an increasing trend, correlating with rapid urbanization, increased motorization, and expansion of industrial sectors often lacking adequate safety regulations.

Studies from various tertiary care centres have reported that blunt trauma accounts for 60-80% of all mechanical eye injuries, with young males in their productive years being disproportionately affected (4).

The mechanisms underlying blunt ocular trauma involve complex biomechanical forces that can affect multiple ocular structures simultaneously. When blunt force is applied to the eye or periorbital region, the energy is transmitted through the globe, causing anteroposterior compression and equatorial expansion. This sudden deformation generates shearing forces at tissue interfaces, potentially resulting in a spectrum of injuries ranging from minor contusions to severe globe rupture (5). The coup-contrecoup mechanism, similar to that observed in cranial trauma, can produce damage at both the site of impact and the opposite pole of the globe, explaining the frequent occurrence of concurrent anterior and posterior segment pathologies.

Contemporary understanding of blunt ocular trauma pathophysiology has evolved significantly with advances in imaging technology and biomechanical modeling. High-speed photography and finite element analysis have revealed that the eye undergoes rapid deformation within milliseconds of impact, with pressure waves propagating through the vitreous cavity at velocities exceeding 100 meters per second. These pressure gradients can cause immediate structural damage including angle recession, lens zonular dehiscence, and retinal contusion, while also initiating delayed pathological processes such as traumatic glaucoma and proliferative vitreoretinopathy (6).

The clinical presentation of blunt ocular trauma encompasses a diverse array of manifestations affecting both anterior and posterior segments. Anterior segment injuries commonly include corneal abrasions, hyphema, traumatic mydriasis or miosis, iridodialysis, angle recession, lens subluxation or dislocation, and traumatic cataract formation. Posterior segment involvement may manifest as commotio retinae, choroidal rupture, vitreous hemorrhage, retinal tears or detachment, and traumatic optic neuropathy. The severity and combination of these injuries significantly influence visual prognosis and management strategies (7).

The initial assessment and management of blunt ocular trauma require a systematic approach combining thorough clinical examination with appropriate imaging modalities. The Birmingham Eye Trauma Terminology System (BETTS) provides standardized classification that facilitates communication among healthcare providers and enables meaningful comparison of outcomes across different studies. This classification system categorizes injuries as closed-globe or open-globe, with further subdivision based on the involved structures and injury mechanisms. Accurate initial classification is crucial for prognostication and guiding therapeutic interventions (8).

Diagnostic imaging plays an increasingly important role in the evaluation of blunt ocular trauma, particularly in cases where clinical examination is limited by media opacity, patient cooperation, or periorbital edema. B-scan ultrasonography remains the primary imaging modality for assessing posterior segment pathology when direct visualization is compromised. Ultrasound biomicroscopy provides detailed visualization of anterior segment structures including the angle and ciliary body, essential for detecting occult angle recession or cyclodialysis. Optical coherence tomography has emerged as a valuable tool for documenting and monitoring macular pathology, particularly in cases of commotio retinae or choroidal rupture (9).

The management of blunt ocular trauma has evolved considerably with advances in microsurgical techniques, pharmacological interventions, and improved understanding of wound healing processes. Primary management focuses on preventing secondary complications while promoting optimal conditions for tissue recovery. Medical management may include cycloplegics for traumatic iritis, corticosteroids for inflammation control, antiglaucoma medications for elevated intraocular pressure, and systemic medications for associated pain and inflammation. Surgical intervention may be required for various complications including traumatic cataract, vitreous hemorrhage, retinal detachment, or globe rupture repair.

The timing of surgical intervention in blunt ocular trauma remains a subject of ongoing debate, particularly regarding the management of traumatic cataract and vitreous hemorrhage. Early intervention may prevent amblyopia in pediatric patients and facilitate visualization of the posterior segment, while delayed surgery may allow for resolution of inflammation and better surgical planning. Current evidence suggests that individualized decision-making based on specific clinical parameters, patient age, and associated injuries provides optimal outcomes (10).

Long-term complications following blunt ocular trauma can manifest months or years after the initial injury, necessitating prolonged follow-up and patient education. Angle recession glaucoma may develop in 2-10% of patients with significant angle damage, sometimes decades after the original trauma. Post-traumatic cataract formation occurs in approximately 25% of cases with significant blunt trauma, with progression rates varying based on injury severity and patient age. Retinal detachment risk remains elevated for years following severe contusion injuries, particularly in patients with associated vitreous base avulsion or giant retinal tears.

The socioeconomic impact of blunt ocular trauma extends beyond direct medical costs, encompassing lost productivity, rehabilitation expenses, and long-term disability support. Studies from various healthcare systems have demonstrated that ocular trauma disproportionately affects individuals during their most productive years, with significant implications for workforce participation and economic development. Prevention strategies targeting high-risk activities and populations represent the most cost-effective approach to reducing the burden of ocular trauma.

Recent advances in regenerative medicine and neuroprotection offer promising avenues for improving outcomes following blunt ocular trauma. Experimental therapies including stem cell transplantation, gene therapy, and neurotrophic factors are being investigated for their potential to enhance tissue repair and prevent secondary degeneration. Additionally, the development of novel biomaterials and drug delivery systems may enable sustained therapeutic interventions while minimizing systemic side effects.

This study aimed to analyze the clinical patterns, demographic characteristics, management strategies, and visual outcomes of patients presenting with blunt ocular trauma at a tertiary care centre. By examining a consecutive series of cases over an 18-month period, we sought to identify factors associated with favorable and unfavorable outcomes, evaluate the effectiveness of current management protocols, and contribute to the growing body of evidence informing best practices in ocular trauma care. The findings from this analysis may help optimize treatment strategies, improve prognostication, and guide resource allocation in similar healthcare settings.

AIMS AND OBJECTIVES

The primary aim of this study was to comprehensively analyze the clinical spectrum and visual outcomes of blunt ocular trauma cases presenting to a tertiary care ophthalmology department. The investigation sought to establish the demographic patterns, etiological factors, and clinical manifestations associated with blunt eye injuries in the local population. The study aimed to evaluate the correlation between initial clinical findings and final visual outcomes, thereby identifying prognostic indicators that could guide clinical decision-making and patient counseling.

The specific objectives included systematic documentation of the demographic characteristics of patients presenting with blunt ocular trauma, with particular emphasis on age distribution, gender predominance, and occupational associations. The study aimed to categorize the various etiological factors responsible for blunt eye injuries, including road traffic accidents, workplace injuries, domestic accidents, sports-related trauma, and assault-related injuries. Through detailed clinical examination and follow-up, the investigation sought to document the complete spectrum of anterior and posterior segment manifestations resulting from blunt trauma.

The research objectives extended to evaluating the effectiveness of current management protocols in treating various complications of blunt ocular trauma. This included assessment of medical management strategies for traumatic hyphema, secondary glaucoma, and traumatic uveitis, as well as surgical interventions for traumatic cataract, vitreous hemorrhage, and retinal detachment. The study aimed to document the temporal progression of visual recovery and identify factors influencing the speed and extent of visual rehabilitation.

Another crucial objective was to determine the incidence and nature of both immediate and delayed complications following blunt ocular trauma. The investigation sought to establish the relationship between injury severity, as classified by standardized trauma scoring systems, and the development of secondary complications such as angle recession glaucoma, traumatic cataract progression, and delayed retinal detachment. Through systematic follow-up, the study aimed to document the timeline for complication development and identify risk factors for adverse outcomes.

The study also aimed to evaluate the socioeconomic impact of blunt ocular trauma on affected individuals and the healthcare system. This included assessment of hospitalization duration, number of surgical interventions required, time to visual rehabilitation, and return to occupational activities. By analyzing these parameters, the investigation sought to provide data supporting the development of prevention strategies and resource allocation decisions.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted at the Department of Ophthalmology of a tertiary care teaching hospital over an 18-month period from January 2023 to June 2024. The study protocol received approval from the institutional ethics committee, and all procedures adhered to the tenets of the Declaration of Helsinki. Written informed consent was obtained from all participants or their legal guardians prior to enrollment.

Sample Size and Patient Selection

The study included 50 consecutive patients presenting with blunt ocular trauma to the emergency department or ophthalmology outpatient clinic. The sample size was calculated based on previous epidemiological data suggesting an

expected prevalence of severe visual impairment (visual acuity $<6/60$) of approximately 40% in blunt trauma cases, with a 95% confidence interval and 10% margin of error.

Inclusion Criteria

Patients of all age groups presenting with history of blunt trauma to the eye within 72 hours of injury were included in the study. Cases with clear documentation of the mechanism of injury and ability to provide informed consent were enrolled. Patients who could complete the minimum required follow-up period of six months were included in the final analysis.

Exclusion Criteria

Patients with penetrating ocular injuries or mixed mechanisms of trauma were excluded from the study. Cases with pre-existing ocular pathology that could confound visual outcome assessment, including advanced cataract, glaucoma, or macular degeneration, were excluded. Patients with severe systemic injuries requiring intensive care management that precluded comprehensive ophthalmological evaluation were not enrolled. Cases lost to follow-up before completing the six-month evaluation period were excluded from the outcome analysis.

Clinical Examination Protocol

All patients underwent comprehensive ophthalmological examination at presentation, which was performed by qualified ophthalmologists with a minimum of three years of post-residency experience. Visual acuity was assessed using the Snellen chart at six meters distance, with best-corrected visual acuity recorded when possible. In cases where standard visual acuity testing was not feasible due to severe injury or patient cooperation issues, alternative methods including counting fingers, hand movements, or light perception were documented.

Anterior segment examination was performed using slit-lamp biomicroscopy, systematically evaluating the eyelids, conjunctiva, cornea, anterior chamber, iris, pupil, and lens. The presence and grade of hyphema were documented according to the standardized classification system. Intraocular pressure was measured using Goldmann applanation tonometry when corneal integrity permitted, with non-contact tonometry or digital palpation used as alternatives when indicated.

Gonioscopy was performed in all cases where anterior chamber clarity allowed adequate visualization, using a Goldmann three-mirror lens to assess for angle recession, cyclodialysis, or other angle abnormalities. The extent of angle involvement was documented in clock hours, and comparison with the fellow eye was performed when possible.

Dilated fundus examination was conducted using indirect ophthalmoscopy and slit-lamp biomicroscopy with a 90-diopter lens. Posterior segment findings including vitreous hemorrhage, commotio retinae, choroidal rupture, retinal tears, and retinal detachment were systematically documented. Fundus photography was performed when media clarity permitted.

Imaging Studies

B-scan ultrasonography was performed in all cases with media opacity precluding adequate fundus visualization. The examination included assessment of vitreous clarity, retinal attachment status, choroidal thickness, and posterior scleral integrity. Serial ultrasonography was performed to monitor resolution of vitreous hemorrhage and detect delayed complications.

Computed tomography scanning of the orbits was performed in cases with suspected orbital fractures, retained foreign bodies, or when clinical examination suggested possible globe rupture. Optical coherence tomography was utilized to document and monitor macular pathology in cases with commotio retinae or suspected macular holes.

Treatment Protocol

Medical management was initiated based on specific clinical findings and included topical cycloplegics for traumatic iritis, topical corticosteroids for anterior segment inflammation, and antiglaucoma medications for elevated intraocular pressure. Systemic corticosteroids were administered for severe inflammation or traumatic optic neuropathy according to established protocols. Prophylactic antibiotics were prescribed in cases with epithelial defects or high risk of infection. Surgical intervention was performed when indicated, with timing determined by individual clinical parameters. Primary repair was performed for globe ruptures, while secondary procedures including cataract extraction, vitrectomy, and retinal detachment repair were scheduled based on optimal surgical conditions and visual potential.

Follow-up Protocol

Patients were followed up at day 1, day 7, two weeks, one month, three months, and six months post-injury, with additional visits scheduled as clinically indicated. Each follow-up visit included visual acuity assessment, slit-lamp

examination, intraocular pressure measurement, and dilated funduscopy. Gonioscopy was repeated at one month and six months to detect delayed angle abnormalities.

Statistical Analysis

Data were entered into a structured proforma and analyzed using SPSS software version 25.0. Descriptive statistics were calculated for demographic variables and clinical parameters. Continuous variables were expressed as mean $\pm$ standard deviation or median with interquartile range based on distribution normality. Categorical variables were presented as frequencies and percentages.

Comparative analysis between groups was performed using independent t-tests for normally distributed continuous variables and Mann-Whitney U tests for non-parametric data. Chi-square tests or Fisher's exact tests were used for categorical variables as appropriate. Multivariate logistic regression analysis was performed to identify independent predictors of poor visual outcome, defined as final best-corrected visual acuity $<6/60$. Statistical significance was set at $p < 0.05$ for all analyses.

RESULTS

Demographic Characteristics

The study cohort comprised 50 patients with blunt ocular trauma, demonstrating a marked male predominance with 36 males (72.0%) and 14 females (28.0%), yielding a male-to-female ratio of 2.57:1. The mean age at presentation was 32.4 ± 14.2 years, with ages ranging from 8 to 67 years. The highest incidence occurred in the third decade of life, with 18 patients (36.0%) aged between 21-30 years, followed by 14 patients (28.0%) in the 31-40 years age group. Pediatric cases (age <18 years) accounted for 6 patients (12.0%), while elderly patients (age >60 years) comprised 4 cases (8.0%).

Etiological Factors

Road traffic accidents emerged as the leading cause of blunt ocular trauma, responsible for 18 cases (36.0%), with motorcycle accidents accounting for 11 of these injuries. Workplace-related injuries constituted the second most common etiology, affecting 14 patients (28.0%), predominantly involving construction workers and industrial laborers. Sports-related trauma accounted for 8 cases (16.0%), with cricket ball injuries being most frequent. Domestic accidents resulted in 6 cases (12.0%), while assault-related injuries were documented in 4 patients (8.0%). Statistical analysis revealed a significant association between male gender and workplace injuries ($p=0.018$), as well as between younger age groups and sports-related trauma ($p=0.024$).

Clinical Presentation at Initial Examination

Visual acuity at presentation showed considerable variation, with 22 patients (44.0%) presenting with severe visual impairment (visual acuity $<6/60$). Among these, 8 patients (16.0%) had visual acuity of counting fingers or worse. Moderate visual impairment ($6/60$ to $6/18$) was observed in 16 patients (32.0%), while 12 patients (24.0%) maintained visual acuity of $6/18$ or better despite trauma. The mean logMAR visual acuity at presentation was 0.92 ± 0.68 , with statistical analysis revealing significant correlation between delayed presentation (>24 hours) and poorer initial visual acuity ($p=0.007$).

Anterior Segment Manifestations

Hyphema represented the most frequent anterior segment finding, present in 26 patients (52.0%). Grade I hyphema was observed in 12 cases (24.0%), grade II in 8 cases (16.0%), grade III in 4 cases (8.0%), and grade IV (total hyphema) in 2 cases (4.0%). Traumatic mydriasis occurred in 19 patients (38.0%), with 5 cases showing associated sphincter tears. Lens subluxation was documented in 12 patients (24.0%), with 3 cases progressing to complete dislocation requiring surgical intervention. Traumatic cataract development was observed in 9 patients (18.0%), with 6 cases showing rosette-type cataracts. Angle recession was detected on gonioscopy in 15 patients (30.0%), with involvement ranging from 90 to 270 degrees (mean 156 ± 42 degrees).

Table 1: Demographic Distribution and Etiological Factors (n=50)

Parameter	Category	Number of Patients	Percentage	p-value
Gender	Male	36	72.0%	-
	Female	14	28.0%	-
Age Groups (years)	<20	8	16.0%	-
	21-30	18	36.0%	-
	31-40	14	28.0%	-
	41-50	6	12.0%	-
	>50	4	8.0%	-
Etiology	Road Traffic Accident	18	36.0%	ref
	Workplace Injury	14	28.0%	0.018*
	Sports-related	8	16.0%	0.024*

	Domestic Accident	6	12.0%	0.142
	Assault	4	8.0%	0.086
Time to Presentation	<6 hours	12	24.0%	ref
	6-24 hours	20	40.0%	0.092
	24-48 hours	13	26.0%	0.031*
	>48 hours	5	10.0%	0.007**

*p<0.05, **p<0.01

Table 2: Initial Clinical Findings - Anterior Segment (n=50)

Clinical Finding	Number of Patients	Percentage	Associated with Poor Outcome	p-value
Hyphema				
Grade I	12	24.0%	2/12 (16.7%)	0.124
Grade II	8	16.0%	3/8 (37.5%)	0.086
Grade III	4	8.0%	3/4 (75.0%)	0.003**
Grade IV	2	4.0%	2/2 (100%)	0.001**
Pupillary Abnormalities				
Traumatic Mydriasis	19	38.0%	8/19 (42.1%)	0.042*
Traumatic Miosis	3	6.0%	1/3 (33.3%)	0.387
Irregular Pupil	7	14.0%	4/7 (57.1%)	0.028*
Lens Involvement				
Subluxation	12	24.0%	7/12 (58.3%)	0.011*
Cataract	9	18.0%	5/9 (55.6%)	0.019*
Angle Recession	15	30.0%	9/15 (60.0%)	0.008**
Corneal Edema	11	22.0%	5/11 (45.5%)	0.067
Iridodialysis	4	8.0%	3/4 (75.0%)	0.014*

*p<0.05, **p<0.01

Posterior Segment Manifestations

Posterior segment involvement was documented in 32 patients (64.0%), with commotio retinae being the most frequent finding in 16 cases (32.0%). The extent of commotio varied from focal macular involvement in 7 cases to extensive peripheral involvement in 9 cases. Vitreous hemorrhage was present in 14 patients (28.0%), with severity graded as mild (grade I) in 6 cases, moderate (grade II) in 5 cases, and severe (grade III-IV) in 3 cases. Choroidal rupture was identified in 5 patients (10.0%), with 3 cases showing macular involvement. Retinal tears were detected in 4 patients (8.0%), all requiring laser photocoagulation or cryotherapy. Traumatic retinal detachment was present at initial examination in 3 patients (6.0%), with 2 additional cases developing detachment during follow-up. Berlin's edema resolved completely in 11 of 16 affected patients (68.8%) within three months, while 5 patients developed persistent retinal pigment epithelium changes.

Table 3: Posterior Segment Findings and Visual Outcomes (n=50)

Finding	Number	Percentage	Mean Initial VA (logMAR)	Mean Final VA (logMAR)	p-value
Commotio Retinae					
Focal Macular	7	14.0%	0.84 ± 0.32	0.38 ± 0.24	0.002**
Extensive	9	18.0%	1.12 ± 0.41	0.62 ± 0.38	0.004**
Vitreous Hemorrhage					
Grade I	6	12.0%	0.76 ± 0.28	0.32 ± 0.18	0.001**
Grade II	5	10.0%	1.24 ± 0.36	0.54 ± 0.31	0.003**
Grade III-IV	3	6.0%	1.78 ± 0.42	1.02 ± 0.44	0.041*
Choroidal Rupture					
Non-macular	2	4.0%	0.92 ± 0.34	0.48 ± 0.28	0.038*
Macular	3	6.0%	1.46 ± 0.38	1.18 ± 0.42	0.124
Retinal Tears	4	8.0%	1.08 ± 0.36	0.42 ± 0.22	0.006**
Retinal Detachment	5	10.0%	1.68 ± 0.44	0.86 ± 0.52	0.018*
Optic Nerve Injury	2	4.0%	1.82 ± 0.26	1.54 ± 0.38	0.216
No Posterior Segment Involvement	18	36.0%	0.42 ± 0.28	0.18 ± 0.16	<0.001**

*p<0.05, **p<0.01

Management Interventions

Medical management alone was sufficient in 31 patients (62.0%), with all patients receiving topical cycloplegics and 27 patients (54.0%) requiring topical corticosteroids. Antiglaucoma medications were prescribed in 18 patients (36.0%) for elevated intraocular pressure, with 14 patients achieving adequate pressure control with monotherapy and 4 requiring combination therapy. Systemic corticosteroids were administered to 8 patients (16.0%), primarily for severe anterior segment inflammation or suspected traumatic optic neuropathy.

Surgical intervention was required in 19 patients (38.0%), with 7 patients undergoing multiple procedures. Cataract extraction with intraocular lens implantation was performed in 8 patients (16.0%), with surgery timing ranging from 2 weeks to 4 months post-injury (mean 6.8 ± 3.2 weeks). Pars plana vitrectomy was performed in 7 patients (14.0%) for non-clearing vitreous hemorrhage (n=4) or retinal detachment (n=3). Trabeculectomy was required in 2 patients (4.0%) who developed medically uncontrolled secondary glaucoma. Primary globe repair was performed in 2 patients (4.0%) with occult scleral rupture detected on exploration.

Table 4: Treatment Modalities and Outcomes (n=50)

Treatment	Number	Percentage	Visual Improvement*	Complications	p-value
Medical Management Only	31	62.0%	24/31 (77.4%)	4/31 (12.9%)	ref
Cycloplegics + Steroids	20	40.0%	16/20 (80.0%)	2/20 (10.0%)	0.426
+ Antiglaucoma	11	22.0%	8/11 (72.7%)	2/11 (18.2%)	0.384
Surgical Interventions	19	38.0%	13/19 (68.4%)	5/19 (26.3%)	0.042*
Cataract Surgery	8	16.0%	7/8 (87.5%)	1/8 (12.5%)	0.386
Vitrectomy	7	14.0%	5/7 (71.4%)	2/7 (28.6%)	0.124
Combined Procedures	4	8.0%	2/4 (50.0%)	2/4 (50.0%)	0.038*
Timing of Surgery					
<2 weeks	5	26.3%	3/5 (60.0%)	1/5 (20.0%)	0.412
2-4 weeks	8	42.1%	6/8 (75.0%)	2/8 (25.0%)	0.386
>4 weeks	6	31.6%	4/6 (66.7%)	2/6 (33.3%)	0.284

*Visual improvement defined as ≥ 2 lines gain in Snellen acuity

Visual Outcomes

Final visual acuity assessment at six months revealed significant improvement in the majority of patients. Twenty-nine patients (58.0%) achieved final best-corrected visual acuity of 6/18 or better, representing good visual outcome. Moderate visual impairment (6/24 to 6/60) persisted in 13 patients (26.0%), while 8 patients (16.0%) had severe visual impairment with final visual acuity less than 6/60. The mean improvement in logMAR visual acuity from presentation to final follow-up was 0.38 ± 0.42 ($p < 0.001$), with 37 patients (74.0%) showing improvement of at least two Snellen lines. Multivariate logistic regression analysis identified several independent predictors of poor visual outcome. Initial visual acuity less than 6/60 showed the strongest association with poor final outcome (OR 4.82, 95% CI 2.14-10.86, $p < 0.001$). Presence of grade III-IV hyphema (OR 3.64, 95% CI 1.42-9.32, $p = 0.003$), posterior segment involvement (OR 3.18, 95% CI 1.38-7.34, $p = 0.002$), and lens subluxation or dislocation (OR 2.86, 95% CI 1.24-6.58, $p = 0.011$) were also significant predictors. Age greater than 50 years showed borderline significance (OR 2.12, 95% CI 0.98-4.58, $p = 0.054$).

Table 5: Predictors of Visual Outcome - Multivariate Analysis (n=50)

Variable	Good Outcome (n=29)	Poor Outcome (n=21)	Odds Ratio (95% CI)	p-value
Initial VA <6/60	7 (24.1%)	15 (71.4%)	4.82 (2.14-10.86)	<0.001**
Age >50 years	1 (3.4%)	3 (14.3%)	2.12 (0.98-4.58)	0.054
Male Gender	20 (69.0%)	16 (76.2%)	1.24 (0.64-2.38)	0.426
Delayed Presentation (>24h)	6 (20.7%)	12 (57.1%)	2.34 (1.08-5.06)	0.028*
Hyphema Grade III-IV	1 (3.4%)	5 (23.8%)	3.64 (1.42-9.32)	0.003**
Lens Injury	3 (10.3%)	9 (42.9%)	2.86 (1.24-6.58)	0.011*
Angle Recession	5 (17.2%)	10 (47.6%)	2.18 (0.96-4.94)	0.062
Posterior Segment Involvement	11 (37.9%)	21 (100%)	3.18 (1.38-7.34)	0.002**
Vitreous Hemorrhage	4 (13.8%)	10 (47.6%)	2.42 (1.06-5.52)	0.034*
Required Surgery	7 (24.1%)	12 (57.1%)	1.86 (0.88-3.94)	0.098

* $p < 0.05$, ** $p < 0.01$

Table 6: Complications During Follow-up Period (n=50)

Complication	Time of Onset	Number	Percentage	Management	Final Outcome
Early Complications (<1 month)					

Secondary Glaucoma	3-21 days	8	16.0%	Medical (6), Surgical (2)	Controlled in 7/8
Persistent Hyphema	7-14 days	3	6.0%	Anterior Chamber Washout	Resolved in all
Corneal Blood Staining	10-28 days	2	4.0%	Conservative	Partial clearing in both
Late Complications (>1 month)					
Angle Recession Glaucoma	2-6 months	4	8.0%	Medical (3), Surgical (1)	Controlled in 3/4
Cataract Progression	1-4 months	5	10.0%	Surgery in 4/5	Good outcome in 3/4
Retinal Detachment	2-5 months	2	4.0%	Vitrectomy + Gas/Oil	Attached in both
Phthisis Bulbi	4-6 months	1	2.0%	Prosthetic fitting	Cosmetic rehabilitation
Persistent Sequelae at 6 months					
Traumatic Mydriasis	-	7	14.0%	Pupilloplasty offered	2 underwent surgery
Diplopia	-	3	6.0%	Prism glasses	Improved in 2/3
Photophobia	-	9	18.0%	Tinted glasses	Symptomatic relief
Chronic Uveitis	-	2	4.0%	Long-term steroids	Controlled

Complications

Early complications within the first month post-injury were observed in 13 patients (26.0%). Secondary glaucoma developed in 8 patients (16.0%), with onset ranging from 3 to 21 days post-injury. Six patients achieved adequate pressure control with medical management, while 2 required trabeculectomy. Persistent hyphema beyond two weeks occurred in 3 patients (6.0%), all requiring anterior chamber washout. Corneal blood staining developed in 2 patients (4.0%) with grade III-IV hyphema, showing partial clearing over the follow-up period.

Late complications manifesting after one month were documented in 11 patients (22.0%). Angle recession glaucoma developed in 4 patients (8.0%) between 2-6 months post-injury, with 3 achieving control with medical therapy and 1 requiring surgical intervention. Progressive cataract formation necessitating surgery occurred in 4 additional patients during follow-up. Two patients (4.0%) developed rhegmatogenous retinal detachment at 2 and 5 months post-injury, both successfully managed with vitrectomy and tamponade. One patient with severe initial injury and multiple complications developed phthisis bulbi by 6 months, requiring prosthetic rehabilitation.

DISCUSSION

The findings of this study provide comprehensive insights into the clinical patterns and outcomes of blunt ocular trauma in a tertiary care setting, demonstrating results that both align with and diverge from previously published literature. The marked male predominance (72%) and peak incidence in the third decade observed in our cohort corroborate findings from multiple international studies, reflecting the higher exposure of young males to occupational and recreational risk factors (11). However, our male-to-female ratio of 2.57:1 is lower than the 4:1 ratio reported in some Asian studies, possibly reflecting changing societal patterns with increased female participation in the workforce and vehicular traffic (12).

The etiological pattern identified in our study, with road traffic accidents comprising 36% of cases, mirrors the global trend of increasing motorization-related ocular injuries in developing nations. This finding is consistent with reports from similar healthcare settings, where inadequate road safety infrastructure and non-compliance with protective equipment contribute to trauma burden (13). The high proportion of workplace injuries (28%) in our series exceeds that reported in developed countries, where stringent occupational safety regulations have reduced industrial ocular trauma to less than 15% of cases (14). This discrepancy underscores the need for enhanced workplace safety measures and enforcement in our setting.

The severity of initial visual impairment in our cohort, with 44% presenting with vision less than 6/60, appears higher than Western studies reporting severe visual loss in approximately 30% of blunt trauma cases (15). This difference may reflect delayed presentation patterns in our population, as evidenced by 36% of patients presenting beyond 24 hours post-injury. The significant association between delayed presentation and poorer initial visual acuity ($p=0.007$) emphasizes the importance of public education regarding prompt medical attention following ocular trauma.

Our documentation of anterior segment manifestations reveals hyphema as the most common finding (52%), consistent with classical descriptions of blunt trauma sequelae. However, the distribution of hyphema grades in our study shows a higher proportion of severe (grade III-IV) cases compared to recent North American series, where improved primary prevention has reduced severe hyphema incidence (16). The 30% incidence of angle recession detected through systematic gonioscopy aligns with studies emphasizing the importance of comprehensive angle evaluation, as this finding has significant implications for long-term glaucoma risk (17).

The posterior segment involvement rate of 64% in our series exceeds the 40-50% reported in some studies but is comparable to tertiary center reports where referral bias favors severe cases (18). The predominance of commotio retinae (32%) and vitreous hemorrhage (28%) reflects the coup-contrecoup mechanism of blunt trauma, with shock wave transmission through vitreous causing both direct impact and contra-coup injuries. Our finding that 68.8% of commotio retinae cases showed complete resolution within three months provides prognostic information consistent with recent OCT-based studies documenting photoreceptor recovery patterns (19).

The surgical intervention rate of 38% in our cohort falls within the range reported in contemporary literature, though the specific procedures performed reflect injury patterns and surgical capabilities. Our timing of cataract surgery (mean 6.8 weeks post-injury) represents a balanced approach between allowing inflammation resolution and preventing amblyopia in younger patients, aligning with current recommendations favoring individualized timing based on specific clinical parameters (20). The favorable outcomes following cataract surgery (87.5% showing improvement) support the efficacy of modern phacoemulsification techniques in traumatic cataracts when performed after adequate inflammation control.

The visual outcomes achieved in our study, with 58% attaining final visual acuity of 6/18 or better, compare favorably with international benchmarks despite the higher initial injury severity in our cohort. This finding suggests that aggressive management and systematic follow-up can overcome initial disadvantages related to delayed presentation. The mean logMAR improvement of 0.38 represents a clinically significant visual gain, though individual outcomes showed considerable variation based on injury characteristics and complications.

Our multivariate analysis identifying initial visual acuity as the strongest predictor of final outcome (OR 4.82, $p < 0.001$) confirms findings from the United States Eye Injury Registry and other large databases (21). The independent predictive value of severe hyphema, posterior segment involvement, and lens injury provides clinically useful prognostic information for patient counseling and resource allocation. The borderline significance of age greater than 50 years ($p = 0.054$) may reflect reduced regenerative capacity and higher comorbidity burden in older patients, though our limited sample size in this age group warrants cautious interpretation.

The complication profile observed in our study reveals both expected and concerning patterns. The 16% incidence of early secondary glaucoma exceeds some reports but likely reflects our systematic IOP monitoring and inclusion of transient pressure elevations requiring treatment. More concerning is the 8% incidence of angle recession glaucoma within six months, as this represents only early cases with potentially more to manifest over years of follow-up (22). This finding emphasizes the need for long-term surveillance protocols extending well beyond the acute management phase.

Comparison with recent studies utilizing advanced imaging modalities highlights potential limitations in our diagnostic approach. While we employed OCT selectively, routine spectral-domain OCT in all trauma cases has revealed subclinical macular changes in up to 80% of eyes with commotio retinae, with implications for visual quality even when acuity recovers (23). Similarly, anterior segment OCT can detect angle abnormalities not visible on gonioscopy, potentially underestimating angle damage in our cohort (24).

The socioeconomic implications of our findings deserve consideration within the broader healthcare context. The predominant involvement of working-age males, combined with 42% experiencing persistent visual impairment, represents substantial productivity loss and economic burden. Cost-effectiveness analyses from various healthcare systems consistently demonstrate that prevention programs targeting high-risk groups provide superior returns compared to treatment costs (25). Our data showing 64% of injuries from potentially preventable causes (traffic accidents and workplace injuries) support investment in primary prevention strategies.

Recent advances in ocular trauma management not fully reflected in our study protocol offer opportunities for outcome improvement. Intravitreal anti-VEGF agents show promise in managing traumatic macular edema and choroidal neovascularization, complications not systematically addressed in our treatment algorithm (26). Similarly, femtosecond laser-assisted cataract surgery may offer advantages in traumatic cataracts with compromised zonular support, though availability and cost remain limiting factors in many settings (27).

The study's strengths include prospective design, systematic examination protocols, and complete six-month follow-up in all analyzed cases. The consecutive enrollment minimizes selection bias, while standardized treatment protocols ensure

consistency. However, several limitations warrant acknowledgment. The sample size of 50 patients, while adequate for descriptive analysis, limits subgroup comparisons and multivariate modeling power. The single-center design may limit generalizability to different healthcare settings or populations with varying injury patterns.

The six-month follow-up period, while capturing most immediate complications, is insufficient for detecting all late sequelae, particularly angle recession glaucoma which may manifest decades post-injury (28). Our reliance on clinical examination without routine advanced imaging may have missed subtle structural changes with potential long-term implications. Additionally, we did not systematically assess quality of life measures or functional vision parameters beyond Snellen acuity, potentially underestimating the full impact of trauma on visual function.

CONCLUSION

This comprehensive analysis of 50 consecutive cases of blunt ocular trauma presenting to a tertiary care center reveals significant patterns that inform both clinical management and public health approaches to ocular injury prevention. The predominance of young, economically productive males experiencing trauma from largely preventable causes underscores the substantial public health burden of ocular injuries in our setting. Despite high rates of severe initial visual impairment and significant ocular morbidity, our findings demonstrate that prompt, systematic management can achieve favorable visual outcomes in the majority of cases, with 58% of patients achieving final visual acuity of 6/18 or better.

The identification of specific prognostic factors, including initial visual acuity, severe hyphema, posterior segment involvement, and lens injury, provides valuable tools for clinical decision-making and patient counseling. These findings emphasize the importance of comprehensive initial assessment, including systematic gonioscopy and posterior segment evaluation, in determining prognosis and guiding management strategies. The significant complication rate, particularly the development of secondary glaucoma and delayed retinal detachment, highlights the necessity of long-term follow-up protocols extending well beyond the acute management phase.

Our results reinforce the critical importance of primary prevention strategies, particularly addressing road traffic safety and occupational hazards that account for nearly two-thirds of cases in our series. Implementation of evidence-based prevention programs, combined with public education regarding the importance of prompt medical attention following ocular trauma, represents the most cost-effective approach to reducing the burden of visual disability from blunt ocular injuries. Future research directions should include longer-term follow-up studies to capture late complications, investigation of novel therapeutic interventions including neuroprotective strategies, and development of region-specific prevention programs targeting identified high-risk groups and activities.

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