

Original Research Article

A study on clinical correlation and ultrasound biomicroscopic findings among cases of blunt ocular trauma

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ABSTRACT

Background: Blunt ocular trauma is a significant cause of ocular morbidity and may result in a wide spectrum of anterior segment abnormalities that are not always detectable on routine clinical examination. Ultrasound biomicroscopy (UBM) is a high-resolution imaging technique that allows detailed visualization of anterior segment structures. The present study aimed to evaluate the correlation between clinical examination findings and ultrasound biomicroscopy findings in patients with blunt ocular trauma.

Methods: This descriptive cross-sectional observational study included 80 patients aged ≥ 12 years with closed-globe blunt ocular trauma presenting to a tertiary care teaching hospital between August 2022 and January 2024. All patients underwent comprehensive ophthalmic evaluation including visual acuity assessment, slit-lamp examination, intraocular pressure measurement, gonioscopy, fundus examination and ultrasound biomicroscopy using 35–50 MHz probes.

Results: Males constituted the majority of cases 80% (n=64), with the highest proportion of patients belonging to the 20–29-year age group 36.3% (n=29). The most common mechanisms of injury were road traffic accidents 33.3% (n=23) and sports injuries 27.5% (n=19). Gonioscopy detected angle recession in 12.5% (n=10) of patients. Ultrasound biomicroscopy identified additional anterior segment abnormalities including zonular dehiscence 22.5% (n=18), lens subluxation 20% (n=16), lens dislocation 7.5% (n=6), cyclodialysis 5% (n=4) and iridodialysis 4.8% (n=4). Ultrasound biomicroscopy also detected occult anterior segment abnormalities that were not evident on routine clinical examination.

Conclusions: Ultrasound biomicroscopy is a valuable adjunctive imaging modality in the evaluation of blunt ocular trauma. It enables detailed assessment of anterior segment structures and facilitates the detection of subtle traumatic abnormalities that may be missed during routine clinical examination, thereby aiding in appropriate management and prognosis.

Keywords: Anterior segment injury, Angle recession, Blunt ocular trauma, Ultrasound biomicroscopy, Zonular dialysis

INTRODUCTION

Ocular trauma is an important cause of visual impairment worldwide and represents a significant public health concern. The World Health Organization estimates that nearly 55 million people sustain ocular injuries each year, with a considerable proportion resulting in temporary or permanent visual loss.^{1,2} Ocular injuries may be broadly classified as closed globe injuries or open globe injuries,

depending on whether the eyewall integrity is maintained.^{3,4}

Blunt ocular trauma, a form of closed globe injury, is frequently encountered in clinical practice and may result in a wide spectrum of ocular damage ranging from minor periocular ecchymosis and subconjunctival hemorrhage to severe complications such as hyphema, retinal injury, optic nerve damage or even globe rupture.⁵ Accurate evaluation of anterior segment structures following blunt

ocular trauma is essential for early diagnosis and appropriate management. However, clinical examination alone may sometimes be limited due to corneal edema, hyphema or other media opacities that obscure visualization of deeper ocular structures.

UBM, first introduced by Pavlin and Foster in the early 1990s, utilizes high-frequency ultrasound (20–100 MHz) to provide high-resolution imaging of anterior segment structures.^{6,7} UBM enables detailed visualization of the anterior chamber angle, ciliary body, iris and zonular apparatus, even in eyes with opaque media. These characteristics make UBM a valuable adjunctive imaging modality in the evaluation of traumatic anterior segment abnormalities.⁸

The present study was undertaken to evaluate the clinical findings and ultrasound biomicroscopic features in patients with blunt ocular trauma and to assess the correlation between clinical examination and Ultrasound biomicroscopy findings.

METHODS

A descriptive cross-sectional observational study was conducted in the Department of Ophthalmology and Emergency Unit of a tertiary care teaching hospital, GMERS Medical College and Hospital, Sola, Ahmedabad, Gujarat. The study was carried out over a period of 18 months from August 2022 to January 2024, during which patients presenting with blunt ocular trauma to the emergency unit and ophthalmology outpatient department were evaluated for clinical and ultrasound biomicroscopic findings.

The sample size was calculated to be 80 patients, based on secondary departmental data estimating a 5% prevalence of blunt ocular trauma. The calculation was performed using a confidence level of 95%, confidence limits of ±5% and a design effect of 1, with an additional allowance for approximately 10% non-response.

Prior to commencement of the study, approval was obtained from the Institutional Ethical Review Board and written informed consent was obtained from all participants. Patients aged ≥12 years presenting with blunt ocular trauma during the study period were included.

Patients with penetrating ocular trauma, those unwilling to participate, patients with unstable vital parameters or severe polytrauma and those with a previous history of intraocular surgery such as cataract surgery, glaucoma surgery or retinal detachment surgery were excluded. A detailed clinical history, demographic details and information regarding the nature and mechanism of injury were recorded for all patients.

All patients underwent detailed ophthalmic evaluation including best corrected visual acuity assessment using the Snellen chart, slit-lamp biomicroscopy, intraocular

pressure measurement using Perkins handheld applanation tonometer and fundus examination using direct ophthalmoscopy, indirect ophthalmoscopy and a 90-diopter lens. Retinal periphery was examined with indentation one week after injury. Visual acuity was converted into decimal equivalents and classified according to the ICD (2018) vision loss grading system. Gonioscopy using a single-mirror gonioscope and UBM using MARVEL II A/B scan with UBM were performed at presentation for most patients.

In cases with hyphema due to the risk of rebleeding or in polytrauma patients who were not cooperative at presentation, UBM examination was deferred and performed four weeks after injury. UBM examination was performed in the supine position using 35 MHz probes for screening and 50 MHz probes for detailed evaluation of anterior segment structures including the iridocorneal angle, ciliary body and zonular apparatus. Clinical and UBM findings were recorded, tabulated and analyzed using frequency counts, percentage calculations and appropriate statistical tests.

RESULTS

A total of 80 patients with blunt ocular trauma were included in the study. The majority of participants were male (n=64, 80%), while 16 participants were female (n=16, 20%). The highest proportion of patients belonged to the 20–29-year age group (n=29, 36.3%), followed by the 30–39-year age group (n=16, 20.0%), while only a small proportion of participants were elderly (≥60 years, n=7, 8.8%) (Table 1).

Regarding occupational distribution, students constituted the largest group (n=32, 40%), followed by workers (n=19, 23.7%). Other occupations included businessmen (n=8, 10%), homemakers (n=7, 8.7%) and several smaller occupational groups, reflecting a diverse background among the study participants (Figure 1).

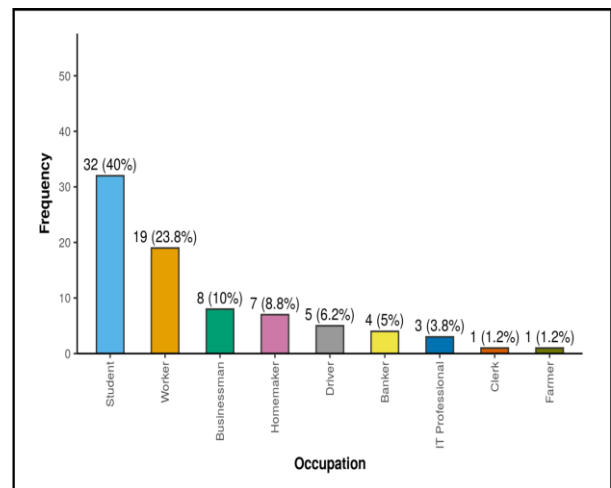


Figure 1: Distribution of participants according to occupation.

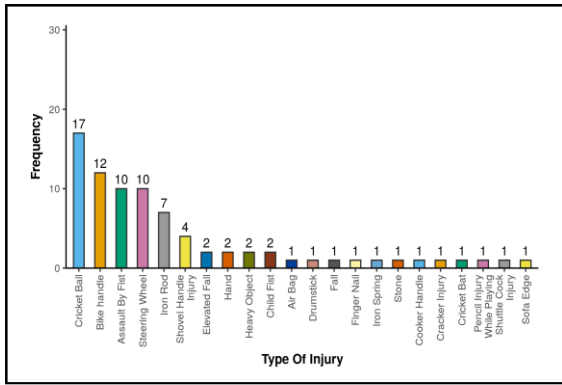


Figure 2: Distribution of participants according to type of injury.

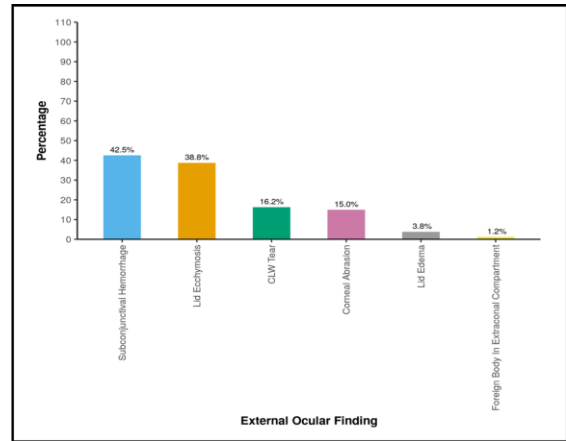


Figure 5: Distribution of various external ocular findings (CLW–contused lacerated wound).

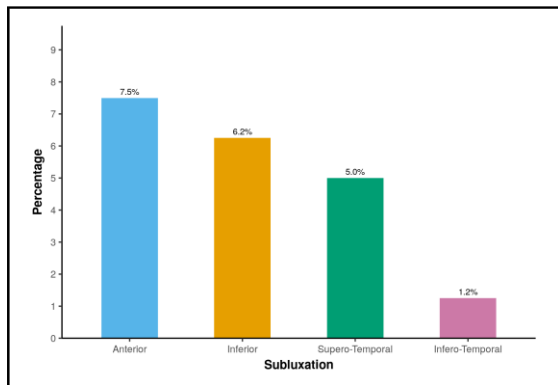


Figure 3: Distribution of participants based on subluxation.

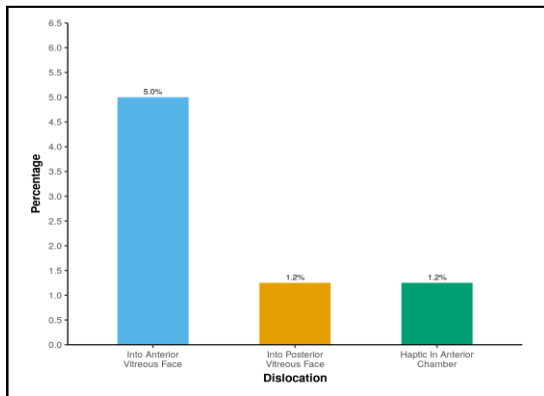


Figure 4: Distribution of participants based on dislocation.

Blunt ocular trauma occurred predominantly in outdoor settings (n=69, 86.2%), while indoor injuries accounted for a smaller proportion (n=11, 13.8%). Among outdoor injuries, road traffic accidents were the most common cause (n=23, 33.3%), followed by sports-related injuries (n=19, 27.5%), workplace injuries (n=16, 23.2%) and assault-related injuries (n=11, 15.9%).

Among specific mechanisms of injury, cricket ball injuries were the most frequently observed (n=17, 21.2%), followed by trauma caused by bike handles (n=12, 15.0%), assault by fist (n=10, 12.5%) and steering wheel injuries (n=10, 12.5%). Other mechanisms such as trauma from iron rods, shovel handles, elevated falls, stones and airbags were less common (Figure 2).

Based on the ICD (2018) classification of vision loss, the majority of patients had none or mild vision loss (n=42, 52.5%), while moderate vision loss was observed in 28 patients (n=28, 35%) and severe vision loss was noted in 10 patients (n=10, 12.5%) (Table 3).

Clinical examination and gonioscopy revealed several anterior segment abnormalities associated with blunt ocular trauma. UBM further aided in the detection of structural abnormalities of the anterior segment, including zonular dehiscence, lens subluxation, lens dislocation and cyclodialysis and also helped identify the extent and localization of angle recession in affected patients (Table 3, 4) (Figure 3, 4).

Table 1: Summary table of the basic details of the participants.

Basic details	Mean±SD Median (IQR) min-max OR N (%)
Age (in years)	35.01±14.87 30.00 (22.75-45.00) 12.00 - 70.00
<20	7 (8.8)
20-29	29 (36.2)
30-39	16 (20.0)
40-49	13 (16.2)
50-59	8 (10.0)

Continued.

Basic details	Mean±SD Median (IQR) min-max OR N (%)
60-69	6 (7.5)
70-79	1 (1.2)
Gender	
Male	64 (80.0)
Female	16 (20.0)
Location of injury	
Outdoor injury	69 (86.2)
Indoor injury	11 (13.8)
Distribution of outdoor injuries	
Assault injury	11 (13.8)
RTA (road traffic accident)	23 (28.7)
Sports injury	19 (23.8)
Workplace injury	16 (20.0)

Table 2: Summary of ophthalmic examination.

Measurements	Mean±SD Median (IQR) Min-Max OR N (%)
Central corneal thickness (mm)	0.51±0.07 0.52 (0.50-0.54) 0.21 - 0.62
Central corneal thickness category	
<0.52	31 (38.8)
0.52-0.54	32 (40.0)
>0.54	17 (21.2)
Anterior chamber depth (mm)	2.91±0.74 2.94 (2.46-3.32) 0.91 - 4.61
Anterior chamber depth category	
<2.48	20 (25.0)
2.48-3.34	41 (51.2)
>3.34	19 (23.8)
Angle opening distance (mm)	0.54±0.19 0.53 (0.40-0.62) 0.13 - 1.10
Angle opening distance category	
<0.5 mm	32 (40.0)
0.5-0.8 mm	38 (47.5)
>0.8 mm	10 (12.5)
Trabecular iris angle (degree)	33.87±8.37 33.45 (30.05-40.00) 10.60 - 59.80
Trabecular iris angle category	
<15°	2 (2.5)
15°-30°	18 (22.5)
>30°	60 (75.0)

Table 3: Summary of ophthalmic examination.

Ophthalmic examination	Mean±SD Median (IQR) Min-Max OR N (%)
Vision	
None/mild loss	42 (52.5)
Moderate loss	28 (35.0)
Severe loss	10 (12.5)
Gonioscopy	
Open	69 (86.2)
Angle recession	10 (12.5)
Peripheral anterior synechiae	1 (1.2)

Table 4: Summary of UBM findings.

Findings	Mean±SD Median (IQR) Min-Max OR N (%)
Angle recession	
12-6 OCP	2 (2.5)

Continued.

Findings	Mean±SD Median (IQR) Min-Max OR N (%)
3-9 OCP	1 (1.2)
2 Quadrants	1 (1.2)
3 Quadrants	3 (3.8)
4 Quadrants	3 (3.8)
Iridodialysis	
12 OCP	1 (1.2)
12-3 OCP	1 (1.2)
11-3 OCP	1 (1.2)
2 Quadrants	1 (1.2)
Cyclodialysis	
3 OCP	3 (3.8)
12 OCP	1 (1.2)
Zonules	
Normal	62 (77.5)
Dehiscence	18 (22.5)

Table 5: Summary of anterior segment findings of the participants.

Anterior segment finding	Yes	No
Subluxation	14 (17.5%)	66 (82.5%)
Traumatic mydriasis	11 (13.8%)	69 (86.2%)
Angle recession	8 (10.0%)	72 (90.0%)
Phacodonesis	5 (6.2%)	75 (93.8%)
Traumatic cataract	5 (6.2%)	75 (93.8%)
Iridodialysis	4 (5.0%)	76 (95.0%)
Dislocation	3 (3.8%)	77 (96.2%)
Hyphaema	2 (2.5%)	78 (97.5%)
Vitreous in anterior chamber	2 (2.5%)	78 (97.5%)
Haptic in anterior chamber	1 (1.2%)	79 (98.8%)
Iris bowing inferiorly at 6 OCP	1 (1.2%)	79 (98.8%)
Peripheral anterior synechiae	1 (1.2%)	79 (98.8%)
Pupillary block with narrow angles	1 (1.2%)	79 (98.8%)
Rupture of anterior lens capsule	1 (1.2%)	79 (98.8%)

(OCP- O Clock Position).

DISCUSSION

In the present study involving n=80 patients, the majority of affected individuals were males 80% (n=64), with the highest incidence observed in the 20–29-year age group 36.3% (n=29). This demographic pattern is consistent with previous studies which have shown that ocular trauma predominantly affects young males due to greater participation in outdoor activities, sports and high-risk occupations. Danenberg et al reported that nearly 97% of patients sustaining ocular trauma were males younger than 40 years of age.⁹ Similarly, Ozdal et al also observed a similar male predominance in patients presenting with blunt ocular injuries.¹⁰

In the present study, road traffic accidents accounted for 33.3% (n=23) of injuries, followed by sports-related trauma 27.5% (n=19) and workplace injuries 23.2% (n=16). These findings are comparable with the observations of Kearns et al who identified motor vehicle accidents as a major cause of blunt ocular injury in their retrospective analysis.¹¹ However, Punnonen et al reported

a higher proportion of sports-related injuries (approximately 40%) in their epidemiological study, suggesting that regional and cultural differences in recreational activities may influence the pattern of ocular trauma.¹²

The relatively high incidence of cricket-related injuries and vehicular trauma in the present study highlights the importance of preventive strategies such as protective sports equipment and improved road safety measures. Visual outcome following blunt ocular trauma depends on the severity of injury and the anatomical structures involved. In this study, evaluation using the ICD-2018 vision loss grading system demonstrated that 52.5% (n=42) of patients experienced none or mild visual loss, 35% (n=28) had moderate visual loss and 12.5% (n=10) had severe visual impairment. These results suggest that the majority of blunt ocular injuries result in mild to moderate visual dysfunction. Similar findings were reported by Ozdal et al who observed moderate visual impairment in approximately 45% of patients with blunt ocular trauma.¹⁰ Early diagnosis and prompt management

therefore play an important role in preventing progression to severe vision loss. The use of standardized grading systems such as the ICD visual impairment classification allows uniform assessment of visual outcomes in trauma studies.¹⁶

Anterior segment findings such as subconjunctival hemorrhage 42.5% (n=34) and lid ecchymosis 38.8% (n=31) were among the most common external manifestations observed in the present study. These findings correspond with those reported by Zagebaum et al who noted that anterior segment injuries frequently accompany blunt ocular trauma, particularly in sports-related injuries.¹³ Posterior segment findings were also documented, with commotio retinae 42.5% (n=34) being the most frequent lesion, followed by posterior vitreous detachment 41.2% (n=33). Commotio retinae has been widely reported as a common consequence of blunt trauma due to transient disruption of photoreceptor outer segments and retinal edema.¹⁴

UBM played an important role in identifying anterior segment abnormalities that may not be clearly visible on clinical examination. In the present study, angle recession was detected in 12.5% (n=10) of cases. This incidence is lower than that reported by Ozdal et al who observed angle recession in approximately 29.3% of traumatized eyes.¹⁰ Clinical gonioscopy remains the standard method for angle evaluation; however, it may be limited in the presence of corneal edema, hyphema or media opacity. UBM provides high-resolution imaging of the anterior segment structures and allows accurate visualization of the ciliary body and iridocorneal angle.

Other anterior segment abnormalities identified using ultrasound biomicroscopy included iridodialysis 4.8% (n=4), cyclodialysis 5% (n=4), zonular dehiscence 22.5% (n=18), lens subluxation 20% (n=16) and lens dislocation 7.5% (n=6). Similar findings have been reported in previous studies evaluating traumatic anterior segment injuries, where zonular damage and lens instability were frequently observed following blunt ocular trauma.¹⁵ Early detection of such abnormalities is clinically important, as they may predispose to complications such as secondary glaucoma, lens instability or the need for surgical intervention.

Overall, the findings of the present study reinforce the important role of ultrasound biomicroscopy as an adjunctive diagnostic tool in blunt ocular trauma, particularly for detecting subtle anterior segment abnormalities that may be missed during routine clinical examination.

The study was limited by a relatively small sample size and its single-center design, which may affect the generalizability of the findings. As a cross-sectional study, it was not possible to determine causal relationships between trauma and observed findings. Additionally, interpretation of ultrasound biomicroscopy images is

operator dependent and the absence of long-term follow-up limited assessment of visual outcomes and complications.

CONCLUSION

Blunt ocular trauma predominantly affects young males, with the highest incidence observed in the 20–29 years age group in the present study. A variety of anterior segment abnormalities were identified following trauma, including angle recession, zonular dehiscence, lens subluxation and lens dislocation. The findings highlight the importance of early and thorough evaluation of traumatic ocular injuries to prevent long-term visual morbidity. UBM proved to be a valuable adjunctive imaging modality for the assessment of anterior segment structures, particularly in cases where media opacity or associated injuries limit clinical examination. UBM enabled detailed visualization of the iridocorneal angle, ciliary body and zonular apparatus, allowing detection of subtle traumatic changes that may not be apparent on routine examination. Early identification of such abnormalities can facilitate timely management and reduce the risk of secondary complications. The study therefore emphasizes the important role of ultrasound biomicroscopy in improving diagnostic accuracy and guiding appropriate management in patients with blunt ocular trauma.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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