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Original Research Article

Evaluation of Macular Involvement Following Blunt Ocular Trauma in a Tertiary Eye Care Centre

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Abstract:

Background: Ocular trauma remains a significant global contributor to visual impairment, often leading to complex structural damage within the eye. Specifically, blunt trauma can trigger a cascade of pathological events, particularly affecting the delicate architecture of the macula, the area responsible for central, high-resolution vision. Understanding the precise macular changes early on is vital for accurate prognostication and timely intervention. The primary aim of this observational study was to assess the spectrum and prevalence of macular involvement in patients who presented with blunt ocular trauma at a tertiary eye care hospital.

Material and Method: A prospective, hospital-based study was conducted from September 2018 to October 2019, enrolling 51 patients who had sustained blunt ocular injuries. Following a comprehensive history and routine clinical examination, all participants underwent detailed slit-lamp examination, fundus examination, and crucially, Optical Coherence Tomography (OCT). OCT provided non-invasive, high-resolution cross-sectional imaging, allowing for microstructural analysis of the macula. Data, including demographic details, mechanism of injury, and clinical findings, were analyzed to draw statistical conclusions.

Result: The results indicated a pronounced male predominance (75%), with the highest incidence occurring in the young population aged 11–20 years, often students (41.18%). The most common cause of injury was sports-related, specifically trauma by a ball (23.53%). Anteriorly, the pupil was the most frequently affected structure (41.17%), typically presenting with traumatic mydriasis. Posteriorly, Retinal Detachment (11.76%) was the most common gross pathology. Utilizing OCT, subtle macular involvement was widely detected, with the most frequent findings being Berlin's Oedema, Lamellar Macular Hole, Macular Oedema, and Macular Scarring (all at 3.92%).

Conclusion: Blunt ocular trauma severely impacts young males and can result in significant visual impairment due to a range of anterior and posterior segment injuries. The study confirms that OCT is an indispensable tool, revealing fine microstructural macular changes that might be missed by conventional clinical examination. Early OCT evaluation is therefore recommended for all blunt trauma cases to guide subsequent management and improve visual outcomes.

Keywords: Blunt Ocular Trauma, Macula, Optical Coherence Tomography (OCT), Berlin's Oedema, Lamellar Macular Hole, Retinal Detachment, Traumatic Mydriasis.

Introduction

Ocular trauma constitutes a significant global public health concern, consistently ranking as a leading preventable cause of visual impairment and monocular blindness across all age groups. [3] About 59.9 million incident cases of eye injury worldwide, with an incidence of ~773 per 100,000 population. [6,7] The resultant damage to the eye is often multifaceted, affecting the anatomical and physiological integrity of both the anterior and posterior segments [3]. Among the various mechanisms of injury, blunt ocular trauma—typically resulting from non-penetrating impacts such as sports injuries, falls, or assaults—is highly prevalent, particularly among young, active males [3]. The shockwaves transmitted through the globe upon impact can lead to a complex array of pathologies, making accurate diagnosis critical for patient prognosis. The posterior segment, and most

importantly the macula, is critically susceptible to these concussive forces. As the anatomical area responsible for central and high-resolution vision, even subtle damage to the macula can result in profound and permanent visual loss. Therefore, prompt and precise identification of all macular injuries is paramount for effective management planning and predicting the ultimate visual outcome of the patient [2].

Historically, the evaluation of the posterior segment relied primarily on clinical examination, which can be limited by accompanying factors such as corneal edema, hyphema, or vitreous opacities. Furthermore, many subtle macular changes, such as early-stage Commotio Retinae (Berlin's Oedema), mild foveal thickening, or minute intraretinal cysts, are often difficult to appreciate with traditional slit-lamp biomicroscopy and direct fundus examination [1]. The introduction of Spectral Domain Optical Coherence Tomography (SD-OCT) has revolutionized the diagnostic approach in trauma. This non-invasive technology provides high-resolution, cross-sectional imaging of the retina, allowing for detailed, microscopic visualization of the retinal layers. SD-OCT is an indispensable tool for detecting, documenting, and quantifying the full spectrum of microstructural changes in the macula following blunt trauma, enabling clinicians to identify lesions that might otherwise be overlooked [1].

Given the high incidence of blunt ocular trauma and the diagnostic advantages offered by OCT, this study was undertaken to comprehensively assess the spectrum and prevalence of macular involvement, utilizing SD-OCT, in patients presenting with blunt ocular trauma at a tertiary eye care hospital.

Material and Methods

This cross-sectional, hospital-based observational study was conducted in the Department of Ophthalmology at a tertiary eye care center over a period of twelve months, from October 2018 to September 2019. A total of 51 patients presenting with blunt ocular trauma were consecutively enrolled. Patients above 10 years of age with a confirmed history of blunt ocular injury were included in the study, while those with penetrating ocular trauma, pre-existing ocular diseases unrelated to trauma, or media opacities preventing OCT evaluation were excluded. For each patient, a detailed history was recorded, including the mechanism of injury, presenting symptoms, duration since trauma, past ocular and systemic history, and any history of previous trauma. A thorough external eye evaluation was first performed using torchlight, noting any adnexal injuries and whether the trauma involved one or both eyes. Unaided visual acuity was assessed using a Snellen visual acuity chart for distance and near vision, supplemented by pinhole testing where necessary. Intraocular pressure was measured using a non-contact tonometer. The anterior segment was evaluated using a slit-lamp biomicroscope to identify corneal abrasions, anterior chamber reactions, iris changes such as traumatic mydriasis, and lens opacities suggestive of traumatic cataract. Posterior segment evaluation was performed with an indirect ophthalmoscope to assess the vitreous, retina, macula, and optic disc for signs of posterior segment involvement, including commotio retinae, vitreous hemorrhage, or retinal detachment. Spectral Domain Optical Coherence Tomography (SD-OCT) was performed in all patients with clear media to document macular microstructural changes such as Berlin's edema, lamellar macular holes, intraretinal cysts, or early macular scarring. Diplopia charting using red-green anaglyph goggles was carried out in patients with complaints of double vision to evaluate extraocular muscle involvement. Radiological investigations, including X-ray orbit (AP and lateral views) and computed tomography (CT) scans, were obtained in suspected cases of orbital rim fractures, blow-out fractures, or peri-orbital trauma.

All clinical and imaging findings, along with demographic details, were systematically documented. The data were entered into Microsoft Excel 2007, and descriptive statistical analysis was performed to derive frequencies, percentages, and ratios, which were subsequently analyzed for interpretation.

Result

In this study, out of 51 patients, majority of the patients were male, i.e. 38 patients (75%), and rest 13 were female (25%). A total of 38 patients (75%) were male, while 13 patients (25%) were female, indicating a clear male predominance in the incidence of blunt ocular trauma. The most commonly affected age group was 11–20 years, accounting for 37.25% of the cases. This was followed by the 21–30 years and 31–40 years age groups, each contributing 19.61% of patients. The least affected groups were those aged 41–50 years and 51–70 years, each representing 7.84% of the study population. This distribution reflects the higher exposure of younger individuals to trauma-related activities.

In this study 31 patients (60.78%) presented with trauma to the left eye, while 19 patients (37.25%) had trauma to the right eye. Only one patient (1.96%) had bilateral blunt ocular trauma. Students constituted the largest occupational group affected, with 21 patients (41.18%) sustaining blunt ocular injuries. The least affected occupational categories included retired individuals, vendors, and officers, with one patient (1.96%) in each group. This

pattern suggests greater vulnerability among younger, active populations, particularly students.

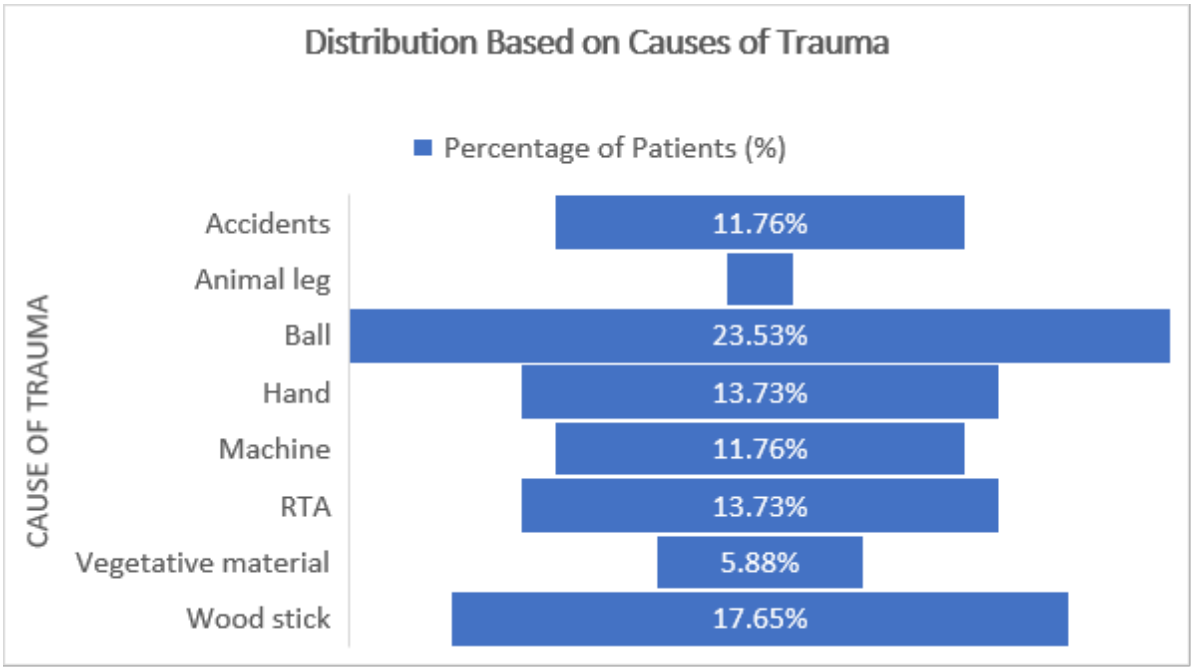

Figure 1: Distribution based on causes of Trauma

Figure 1 shows that the most frequent cause of blunt ocular trauma was sports-related ball injuries, accounting for 12 cases (23.53%). The least common cause was injury due to an animal leg, noted in one patient (1.96%). Other causes included domestic accidents, road traffic injuries, physical assault, and occupational hazards.

At presentation, the visual acuity of the right eye ranged from 6/6 to no perception of light (NPL). The largest proportion—30 patients (58.82%)—had visual acuity between 6/6 and 6/18, indicating relatively preserved central vision in many patients at the time of examination.

Similarly, left-eye visual acuity also ranged from 6/6 to NPL. A total of 21 patients (41.18%) demonstrated visual acuity between 6/6 and 6/18. Lower levels of vision were seen in those with significant anterior or posterior segment pathology.

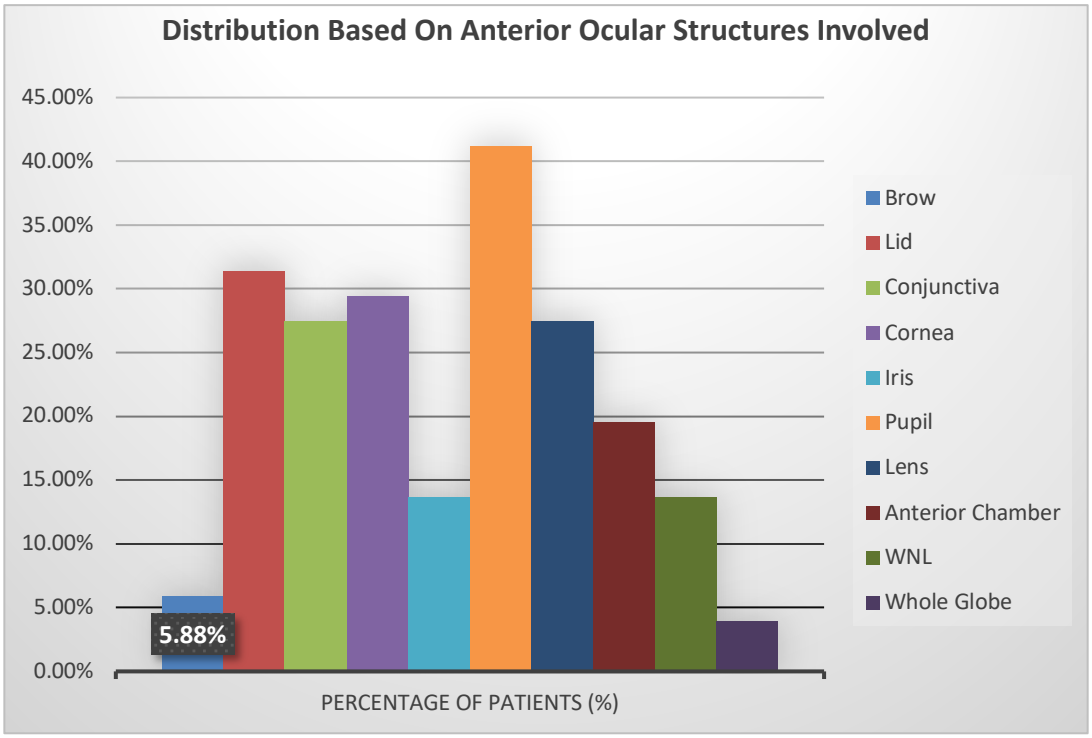

Figure 2: Distribution Based On Anterior Ocular Structures Involved

Figure 2 shows that most patients exhibited involvement of multiple anterior segment structures. The most frequently affected structure was the pupil, with 21 patients (41.17%) showing signs of pupil-related injury, including traumatic mydriasis or irregular pupil configuration. The most common ocular manifestation was traumatic mydriasis, observed in 11 patients (21.56%). "Other pathologies" comprised 25.49% of all anterior segment findings and included a range of conditions such as brow abrasions, conjunctival tears, posterior synechiae, iris bombe, limbal tears, ptosis, corneal opacity or scarring, irregular or peaked pupils, and cases of endophthalmitis.

Table 1: Distribution Based on Macular Involvement

Macular Involvement	Number of patients
Berlin oedema	2(3.92%)
CME (snow ball)	1(1.96%)
Foveal Contour thinning	1(1.96%)
Juxtafoveal pigment scar	1(1.96%)
Lamellar macular hole	2(3.92%)
Macular atrophy	1(1.96%)
Macular detachment	1(1.96%)
Macular detachment + ARMD	1(1.96%)
Macular oedema	2(3.92%)
Macular scarring	2(3.92%)
RP with foveal thinning	1(1.96%)

Table 1 shows Spectral-domain OCT revealed macular abnormalities in several patients with blunt ocular trauma. The most common findings were Berlin's edema (3.92%), lamellar macular holes (3.92%), macular scarring (3.92%), and macular edema (3.92%). Although each lesion was observed in a small proportion of patients, their detection was critical due to the potential impact on central visual prognosis

Discussion

The eye is one of the most delicate organs of the human body, and any trauma can result in visual impairment or even permanent blindness, thereby affecting the patient's personal, social, and occupational functioning. With increasing population and activity levels, the incidence of ocular injuries is rising. In the present study, the highest incidence of blunt ocular trauma was observed in the 11–20-year age group (37.25%). This finding is comparable to that of Shobha G. Pai et al. [4], who reported a peak incidence in the 10–20-year group (28.12%), and to Suryaprakash A. V. et al. [1], who found maximum cases in the 20–29-year age group (60%). Our result is contrast to Chen B, et al. [9] and Pelletier J et al. [10] Thus, most blunt ocular trauma cases occur in young individuals (<30 years).

According to WHO data, males are at a higher risk for ocular injuries than females. The present study also showed a male predominance (75% males vs. 25% females), consistent with previous studies. Suryaprakash A. V. et al. [1], Sahu SK, et al (8) and Faizan et al. [5] similarly reported higher incidence among males, with Faizan et al. documenting an M:F ratio of 3.39:1. Shobha G. Pai et al. [4] also found young males to be more vulnerable to ocular trauma. Unilateral (monocular) injuries were more common than bilateral injuries. Trauma to the left eye was seen in the majority of cases (60.78%). In contrast, Suryaprakash A. V. et al. [1] reported predominant involvement of the right eye (60%).

Regarding visual acuity at presentation, 30 out of 51 patients had right eye visual acuity between 6/6–6/18, and only two patients had no perception of light (NPL). In the left eye, 21 patients had visual acuity between 6/6–6/18, and one patient had NPL. These findings correlate with those of Shobha G. Pai et al. [4], who reported that most patients (18 out of 32) had visual acuity of 6/9 or better, and none had NPL.

In terms of occupation, the majority of affected individuals were students (41.18%), followed by farmers (17.65%), housewives (11.76%), businessmen (7.84%), workers (7.84%), office workers (3.92%), teachers (3.92%), retirees (1.96%), officers (1.96%), and vendors (1.96%). This distribution is in agreement with Faizan et al. (5), who also reported students (35.14%) as the most affected occupational group.

Sports-related injuries caused by a ball were the most common mode of trauma (23.53%), followed by injuries due to wooden sticks (17.65%), hand impact (13.73%), road traffic accidents (13.73%), accidental injuries (11.76%), machine-related injuries (11.76%), vegetative material (5.88%), and animal kick (1.96%). Shobha G. Pai et al. [4] had reported RTA as the most common cause (28.12%), whereas Faizan et al. [5] found agricultural and occupational hazards as the predominant causes. The most frequently involved anterior segment structure in this study was the

pupil (41.17%), followed by eyelid involvement (31.37%). In contrast, Shobha G. Pai et al. [4] reported conjunctiva (84.37%) as the most commonly affected structure, followed by eyelid and adnexal injuries (62.5%). Faizan et al. [5] observed corneal involvement (48.01%) as most common.

The most common anterior segment pathology noted was traumatic mydriasis (21.56%), followed by traumatic cataract (17.64%). However, Shobha G. Pai et al. [4] found conjunctival congestion (43.75%) as the most frequent injury, while Faizan et al. [5] reported corneal ulcer/abrasion (48.01%) as the predominant lesion.

Posterior segment findings in the present study included: commotio retinae (3.92%), lamellar macular hole (3.92%), macular edema (3.92%), macular scarring (3.92%), cystoid macular edema (1.96%), foveal contour thinning (1.96%), juxtafoveal pigment scar (1.96%), macular atrophy (1.96%), macular detachment (1.96%), macular detachment with ARMD (1.96%), RP with foveal thinning (1.96%), choroidal rupture (1.96%), retinal detachment (11.76%), vitreous detachment (9.80%), vitritis (9.80%), optic neuropathy (5.88%), posterior vitreous detachment (3.92%), optic atrophy (3.92%), optic nerve avulsion (3.92%), and retinal tear (1.96%). Suryaprakash A. V. et al. [1] reported foveal involvement in 63.3% cases, commotio retinae in 46.6%, macular hole in 13.3%, and choroidal rupture in 6.6%. Shobha G. Pai et al. [4] documented vitreous hemorrhage in one case and commotio retinae in two cases.

X-ray orbit findings in the present study were normal in most patients (50.98%). Orbital wall fractures were noted in 4 patients (7.84%), while one patient each (1.96%) had frontal sinus involvement and medial wall disruption.

Conclusion

Blunt trauma forms a major share of ocular injuries. In this study, most patients were males, with the highest incidence in the 11–20-year age group. Ball-related injuries were the most common cause. The pupil was the most frequently affected structure, followed by the eyelid.

Traumatic mydriasis was the most common anterior segment finding, while posterior segment involvement included retinal detachment, vitreous haemorrhage, vitritis, optic neuropathy, optic nerve avulsion, posterior vitreous detachment, optic atrophy, choroidal rupture, and retinal tears. OCT revealed macular changes such as Berlin's oedema, lamellar macular holes, macular oedema and scarring, cystoid macular oedema, foveal contour thinning, pigment scars, macular atrophy, macular detachment (with or without ARMD), and foveal thinning. Blunt ocular trauma can cause variable structural damage, and the visual prognosis depends on the extent and site of injury. OCT remains an important tool for detecting subtle macular changes and guiding management.

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