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Ocular Injuries And Visual Outcomes Associated With Maxillo-Facial Trauma - An Observational Study

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ABSTRACT

Background*: Maxillofacial trauma is a common global injury, often accompanied by ocular injuries due to the anatomical proximity of the face to the eye. Such trauma, frequently resulting from road traffic accidents, assaults, or falls, can lead to complications ranging from periorbital edema to severe vision-threatening conditions like globe rupture and optic nerve damage. Comprehensive management requires a multidisciplinary approach involving maxillofacial surgeons and ophthalmologists to prevent permanent visual impairment.*

Method: *This prospective observational study was conducted over 18 months at the Adichunchanagiri Institute of Medical Sciences, Karnataka. A total of 129 patients with maxillofacial injuries were recruited based on specific inclusion criteria. Detailed ophthalmologic examinations, including visual acuity tests, anterior and posterior segment evaluations, intraocular pressure measurements, and radiologic investigations such as CT scans, were performed. Data were analyzed statistically with SPSS software to assess ocular injury prevalence and visual outcomes.*

Results: *Among the 129 patients (73.6% male, mean age 34.2 years), road traffic accidents were the leading cause of injury (62%). Zygomaticomaxillary complex (ZMC) fractures were most common (38.8%), followed by mandibular (27.1%), nasal (18.6%), and orbital fractures (11.6%). Ocular injuries included periorbital edema (50.3%) and subconjunctival hemorrhage (31%), with less frequent but severe injuries such as globe rupture (3.1%) and traumatic optic neuropathy (6.2%). Visual acuity improved over six months, with 58.1% of patients regaining near-normal vision (6/6 to 6/12). Severe irreversible visual loss persisted primarily in cases with globe rupture or optic nerve damage.*

Conclusion: *The study underscores the significant association between midfacial fractures, particularly ZMC and orbital fractures, and ocular injuries. Early ophthalmologic assessment and a multidisciplinary approach are vital to optimize visual recovery and facial reconstruction. Preventive public health measures, including road safety and protective equipment use, are essential to reduce trauma incidence. Further studies with larger samples and longer follow-ups are warranted to evaluate long-term ocular outcomes.*

Keywords: *Maxillofacial trauma, ocular injuries, visual outcomes, zygomaticomaxillary complex fractures, globe rupture, traumatic optic neuropathy, multidisciplinary management*

INTRODUCTION:

Maxillofacial trauma represents a significant portion of global trauma cases, with fractures in this region being a common occurrence in head injury patients. The high incidence of maxillofacial skeletal fractures, affecting approximately 200-300 per 100,000 individuals annually, underscores the critical nature of this condition. Around 25% of such cases are accompanied by damage to the eyeball, thereby affecting vision. The interplay between facial fractures and ocular injuries introduces a complex challenge that necessitates a comprehensive and multidisciplinary approach to treatment. [1]

Etiology of trauma to the maxillofacial region encompasses injuries due to assaults or falls, road traffic accidents and sports injuries among other causes. The proximity of the midface to the ocular structures makes it vulnerable to injuries that can result in significant morbidity, including permanent vision loss. Management of such injuries is more complicated due to the complex nature of midface anatomy with its intricate network of bones, muscles, nerves, and blood vessels. There is potential for ocular complications such as globe rupture, retinal detachment, or optic nerve damage which necessitate immediate and precise intervention in order to prevent long-term consequences. [2] A multi-disciplinary approach involving maxillofacial surgeons, ophthalmologists, and other relevant specialists is therefore required to manage ocular injuries resulting from mid-face trauma.

The primary goal of management is to stabilize the patient's condition, address the facial fractures, and simultaneously manage any ocular injuries to prevent further damage. A coordinated approach is essential in outlining a definitive treatment plan that prioritizes both the restoration of facial structure and the preservation of visual function. Failure to adequately address ocular injuries in the context of maxillofacial trauma can lead

to suboptimal outcomes, including permanent vision loss, which carries significant social and medicolegal implications. [3]

Although uncommon, blindness following craniofacial trauma remains a serious concern with a global prevalence ranging from 0% to 11%. [4] A thorough ocular examination is of vital importance in each and every patient with mid-face injury. Early diagnosis of ocular injuries is essential as timely management of injuries can greatly enhance functional outcome. Patients suspected to have an eyeball injury should be immediately referred to an ophthalmologist for a detailed assessment. This includes evaluating the integrity of the globe, optic nerve function and to look for any retinal or choroidal damage. Advanced imaging techniques, such as computed tomography (CT) scans and magnetic resonance imaging (MRI), play a crucial role in diagnosing both bony and soft tissue injuries that may not be immediately apparent. [5]

One of the key challenges in managing maxillofacial trauma with concurrent ocular injuries is the timing of surgical intervention. Fracture fixation is often necessary to restore facial symmetry and function, but if performed before addressing ocular injuries, it may exacerbate visual damage. For instance, manipulating fractured bones without stabilizing a globe injury could lead to further displacement of the eye, worsening the patient's visual prognosis. Therefore, a careful balance must be struck between addressing the fractures and protecting the patient's vision, with the latter taking precedence in cases where there is a risk of permanent visual impairment. [6]

Complications such as enophthalmos, where the eye is sunken into the orbit, or diplopia, where the patient experiences double vision, can result from improper fracture management. These conditions not only affect the patient's appearance but also have functional implications that can be difficult to correct if not addressed early. [7]

METHODOLOGY

This was a hospital-based prospective observational study conducted for a period of 18 months in the Department of Ophthalmology at Adichunchanagiri Institute of Medical Sciences in Karnataka. This study aimed to recruit a representative cohort of patients suffering from maxillofacial injuries who visited our OPD during the study period. The study participants were selected based on specific inclusion and exclusion criteria to ensure a focused and relevant sample for assessing ocular injuries and visual outcomes associated with maxillofacial trauma. Patients who met the inclusion criteria, including those aged 18 years or older and those without previous head or ocular injuries, were enrolled in the study. Exclusion criteria included patients with congenital ocular anomalies or systemic conditions affecting ophthalmic function, ensuring that the study focused solely on the impact of maxillofacial trauma on ocular health. The study included detailed ophthalmologic assessments, such as Snellen visual acuity tests, anterior and posterior segment examinations, and intraocular pressure measurements. These evaluations were performed by certified observers using standardized protocols, including the Birmingham Eye Trauma Terminology (BETT) and ICD-10 classifications. For each participant, detailed demographic information and medical history was documented. Radiological investigations like CT scan of head, neck and orbit were also taken into record. The data was analysed using SPSS software. Results were presented in terms of percentages, proportions, and significance levels, with a p-value of <0.05 considered statistically significant.

RESULTS

The study involved 129 patients with maxillofacial trauma. Age of the subjects were between 11 years to 70 years. Mean age was 34.2 years (SD= 9.84). Majority of the cases were between 31-40 years (44.96%) and least among 61-70 years (1.55%). Majority of the patients were male (73.6%) and the remaining were female (26.4%). Out of 129 patients, 62% were working adults and 38% were non- working.

Three modes of injury were considered for the study. Most of the injuries occurred due to road traffic accidents (62.0%), followed by fall (23.3%) and assault (14.7%). Zygomaticomaxillary Complex (ZMC) fractures were most commonly seen (38.8%), followed by mandibular fractures (27.1%), nasal fractures (18.6%), orbital fractures (11.6%) and le fort fractures (3.9%). This indicates that midfacial fractures, such as ZMC and mandibular fractures, have a strong association with potential ocular complications, underscoring the need for comprehensive ophthalmic evaluation in these patients. Periorbital oedema was the most common ocular injury found in (50.3%) of the patients with mid-facial injury followed closely by subconjunctival haemorrhage (31.0%). More severe injuries, such as globe rupture (3.1%) and traumatic optic neuropathy (6.2%), were less frequent but highlight the risk of significant ocular damage in these patients. This reinforces the importance of ocular screening in all patients with maxillofacial trauma. At follow up, ocular complications such as cataract

(2.3%), retinal detachment (1.6%), and optic nerve atrophy (0.8%) were observed. These complications, although less common, are significant as they can lead to long-term visual impairment and require ongoing management. Monitoring and addressing these complications early can help prevent further deterioration in vision. **[Figure 1]**

At presentation, most patients had moderate visual impairment, with 42.6% presenting with visual acuity between 6/18 and 6/60. A small proportion of patients (7%) had no light perception, indicating severe visual impairment. At 1 week, the majority of patients (40.3%) had visual acuity between 6/18 and 6/60, showing slight improvement after initial treatment. A small percentage (3.1%) of patients continued to have no light perception, indicating the severity of some ocular injuries at the time of presentation. **[Table 1]** At 3 weeks and 6 weeks follow up there was further improvement in visual acuity than 1 week follow up. By 6 months, 58.1% of patients had recovered to a visual acuity of 6/6 to 6/12, indicating substantial improvement in many cases. **[Figure 2]** 1.5% of patients still had no light perception, which could reflect the irreversible damage caused by globe rupture or optic nerve injury. Despite the improvements in visual acuity, some patients continued to experience permanent visual impairment, emphasizing the importance of early detection and management. However, the patients having no light perception had no improvement. At the end of the study period, 58.1% of patients had recovered to a visual acuity of 6/6 to 6/12.

Most patients had a normal intraocular pressure (93%), which was checked digitally, indicating no immediate signs of glaucoma or increased ocular pressure at presentation. 7% of patients had elevated intraocular pressure and 1.6% had low intraocular pressure which could be due to trauma related inflammation or other ocular complications and may require monitoring and intervention. 65.9% patients stayed in the hospital for 1-3 days, reflecting the fact that most of the injuries were not life-threatening or required immediate surgical intervention. 23.3% of patients required longer stay, likely due to the need for surgical intervention and observation of their ocular or maxillofacial injuries.

Visual recovery was most favourable in patients with mandibular fractures (87.8%) and Zygomaticomaxillary Complex (ZMC) fractures (82.3%), while orbital fractures had a slightly lower recovery rate (66.7%). The recovery rate was lowest in Le Fort fractures (60%), indicating that the more severe midfacial fractures tend to result in more complications and a slower recovery in terms of visual outcomes. **[Figure 3]**

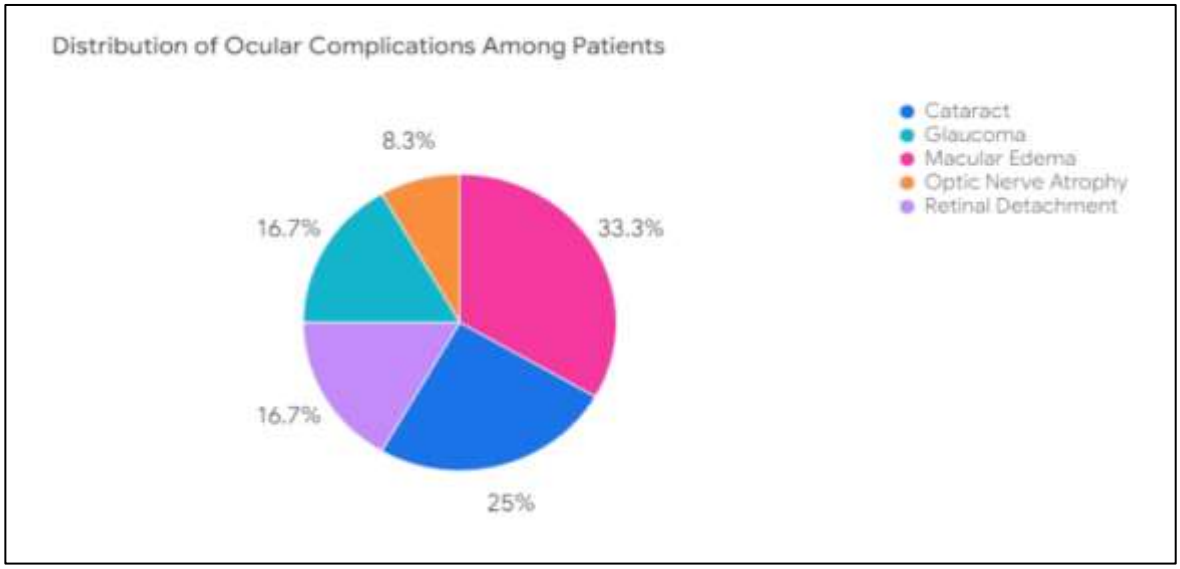


Fig 1: Distribution of ocular complications among patients during follow up

Table 1: Distribution of visual acuity at presentation and during follow up at 1 and 3 weeks

Visual acuity (Snellen chart)	No. of patients at presentation	Follow up at 1 week	Follow up at 3 weeks
6/6-6/12	31(24%)	50(38.8%)	55(42.6%)
6/12-6/18	9(6.9%)	3(2.3%)	2(1.5%)
6/18-6/60	55(42.6%)	52(40.3%)	55(42.6%)
3/60-1/60	29(22.5%)	15(11.6%)	12(9.4%)

Light Perception	3(2.3%)	5(3.9%)	2(1.5%)
No light perception	2(1.6%)	4(3.1%)	3(2.3%)

Fig 2: Distribution of follow up visual acuity at 6 months

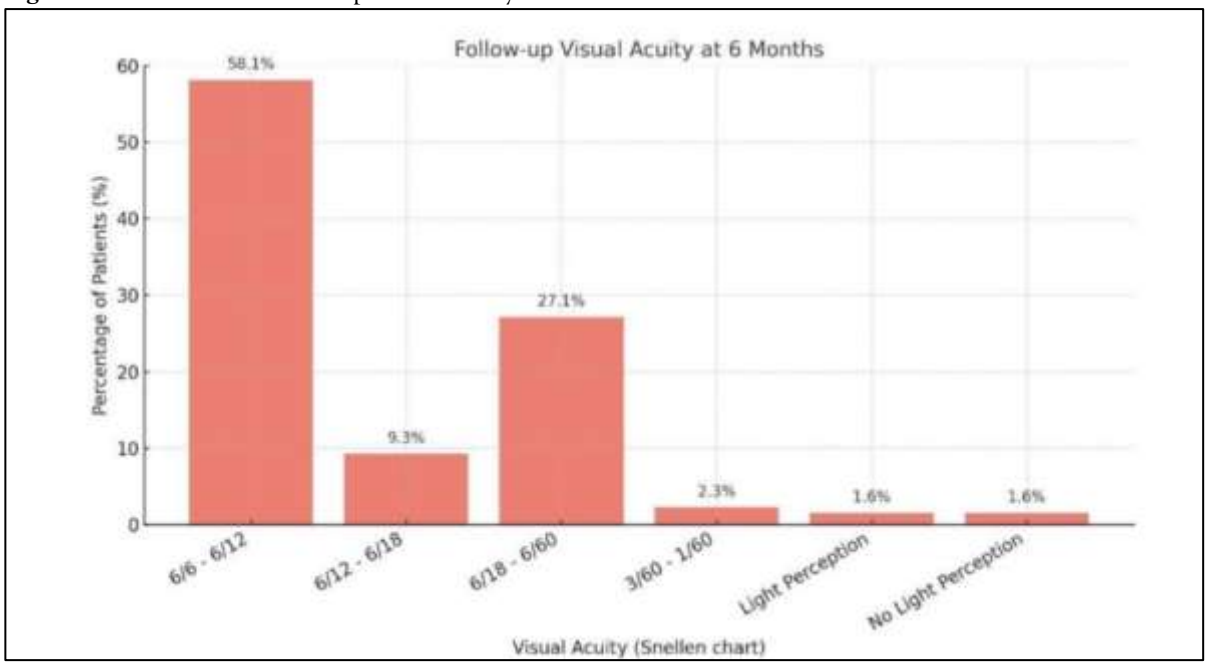
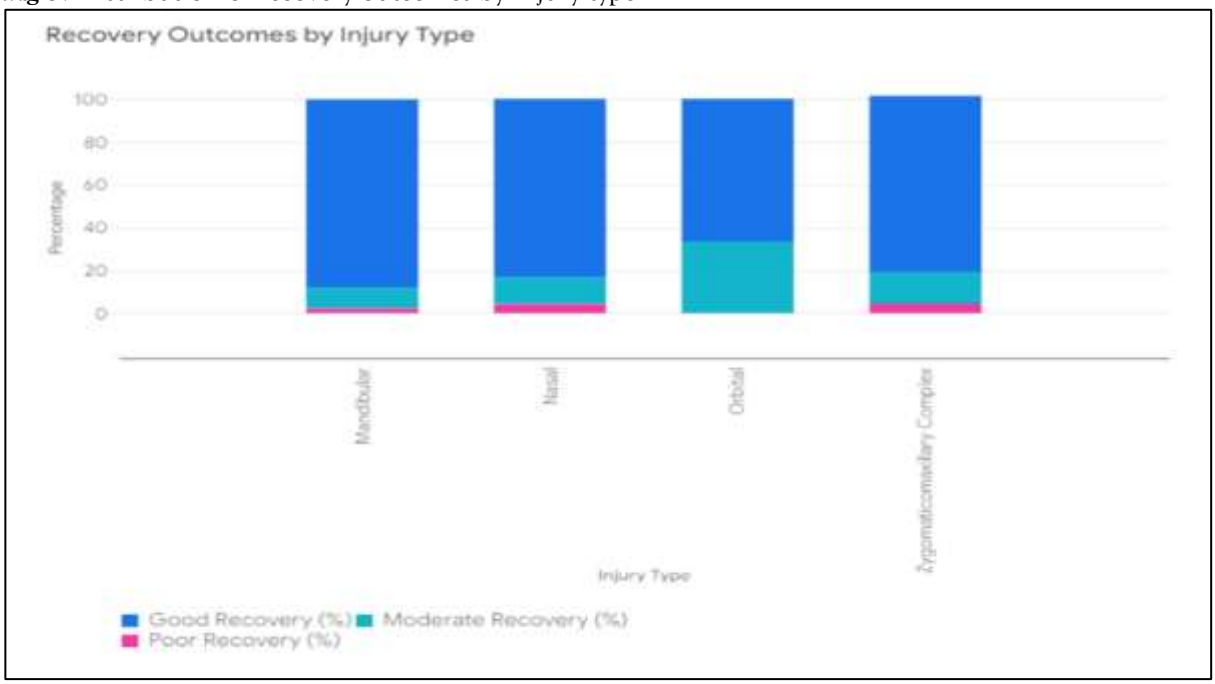


Fig 3: Distribution of recovery outcomes by injury type



DISCUSSION

Similar to the demographic findings of our study, HH Zhou et al. reported a mean age of 32.40 years with a male-to-female ratio of approximately 5.33:1 in 2014. [8] DC Patidhar et al. in 2023 documented that the majority of patients sustained injuries in the 16–25-year age group with a pronounced male predominance, highlighting that this demographic is consistently at greater risk for maxillofacial and associated ocular injuries. [9] A study by M Perry et al. in 2005 emphasized that facial trauma—whether isolated or associated with other injuries—requires a systematic, repeated assessment due to its potential to impact both life- and sight-threatening domains. [10] The convergence of our findings with those of these earlier studies not only validates the

demographic profile typical of facial trauma but also underscores the importance of designing targeted preventive strategies and allocating healthcare resources appropriately.

Our study identified a diverse spectrum of maxillofacial fractures. The predominance of ZMC and mandibular fractures underscores the vulnerability of the midface to high-impact trauma, particularly in road traffic accidents. These findings are consistent with those reported by SM Jain et al. in 2022. [11] Their study found that fractures of the zygomaticomaxillary complex are highly correlated with ophthalmic complications. M Dalband et al. (2022) further demonstrated that while mandibular fractures tend to be classified as "low-risk" for associated ocular injuries, ZMC fractures pose a significantly higher risk, a conclusion that mirrors our observed frequency of orbital involvement in 11.6% of cases. [3] In contrast, the relatively low incidence of Le Fort fractures (3.9%) in our study might reflect either the lower frequency of such injuries or differences in the population demographics and trauma mechanisms when compared with prior research.

The spectrum of ocular injuries observed in our study were similar to findings by F. Roccia et al. in 2011, who reported that facial fractures in the middle third, especially those affecting the orbital walls, were associated with severe ocular complications such as direct globe lesions and traumatic optic neuropathy. [5] In addition, SC Balla et al. (2022) observed that adnexal and globe injuries are common among patients with maxillofacial trauma, with soft tissue injuries being predominant, while vision-threatening conditions like traumatic optic neuropathy, though infrequent, necessitate urgent intervention. [2]

The progressive gain in visual acuity from the time of presentation till follow up at 1 week, 1 month, 3 months and 6 months highlights the benefits of early and targeted intervention in managing ocular trauma. This trend aligns with the findings of HH Zhou et al. (2014), who noted significant visual improvements following early treatment protocols in patients with facial fractures and ocular injuries. [8] Similarly, SM Jain et al. (2022) reported that prompt ophthalmic management in maxillofacial trauma was strongly associated with better visual recovery, particularly in cases involving midfacial fractures. [11] JF Eng et al. (2023) further emphasized that timely ophthalmologic evaluation and treatment are critical for mitigating long-term visual impairment, especially in patients with complex injuries. [12] The observed VA improvements over time in our study suggest that comprehensive management strategies—combining both medical and surgical interventions— can yield favourable outcomes even in patients presenting with severe initial visual deficits.

Our study's evaluation of intraocular pressure and CT scan findings provided critical insights into the structural and functional status of the injured eyes. CT scans, performed as part of the comprehensive assessment, revealed orbital fractures in 40.3% of patients, along with maxillary (29.5%), mandibular (27.1%), and nasal fractures (15.5%). These imaging findings underscore the significant association between midfacial fractures and potential ocular compromise. M Dalband et al. (2022) similarly reported a high prevalence of orbital rim fractures in patients with maxillofacial trauma, underscoring the importance of imaging in detecting subtle yet clinically significant orbital involvement. [3] The elevated IOP observed in a minority of our patients aligns with reports by SC Balla et al. (2022) , who noted that increased ocular pressures can result from traumatic inflammation and may require prompt intervention to prevent secondary glaucomatous damage. [2]

Treatment strategies in our study were tailored to the severity of both the maxillofacial and ocular injuries. A majority of patients (58.1%) were managed conservatively through observation, while 38.8% received medical management, and a smaller subset (3.1%) underwent surgical repair for severe conditions such as globe rupture. This approach is further validated by the favourable post-surgical outcomes observed, with 100% of surgically treated patients demonstrating good recovery by 6 months. The convergence of our treatment outcomes with prior research highlights the importance of integrating standardized ophthalmologic protocols into trauma care, ensuring that patients with severe injuries receive the rapid and specialized care needed to optimize visual recovery. This approach is further validated by the favourable post-surgical outcomes observed, with 100% of surgically treated patients demonstrating good recovery by 6 months. The convergence of our treatment outcomes with prior research highlights the importance of integrating standardized ophthalmologic protocols into trauma care, ensuring that patients with severe injuries receive the rapid and specialized care needed to optimize visual recovery. Additionally, our data are in concordance with findings from the study by JF Eng et al. (2023), who underscored that effective surgical management plays a critical role in reducing long-term visual deficits. [12] The relatively short duration of hospitalization for most patients suggests that many injuries, although complex, can be managed efficiently with prompt intervention and proper rehabilitation. However, the extended hospital stays for a subset of patients highlight the necessity for individualized care plans, particularly for those with severe injuries or complications. When stratified by injury type, mandibular fractures demonstrated the highest rate of good visual recovery (87.8%), followed by Zygomaticomaxillary Complex (ZMC) fractures at 82.3%, whereas orbital fractures and Le Fort fractures exhibited lower recovery rates, with

orbital fractures showing 66.7% good recovery and Le Fort fractures only 60%. These findings were in concordance with previous research by Yamsani B et al. [13]

CONCLUSION

By analysing a comprehensive dataset of 129 patients, the study sought to elucidate the correlation between specific facial fracture patterns—such as zygomaticomaxillary complex, mandibular, and orbital fractures—and the occurrence of various ocular injuries, ranging from minor periorbital oedema to severe complications like globe rupture and traumatic optic neuropathy. This investigation was driven by the need to bridge the gap between maxillofacial trauma and ocular morbidity, recognizing that the intricate anatomical relationship between the facial skeleton and the orbital structures necessitates a more integrated approach in trauma management. The strong association between specific fracture types and ocular injuries suggests that clinicians should be particularly vigilant when treating injuries involving the zygomaticomaxillary complex and orbital structures. This understanding can help to form more precise triage system so that high risk patients receive timely intervention. From a public health perspective, there is a critical need to adopt preventive measures such as enhanced road safety protocols and the promotion of protective equipment in order to reduce the incidence of such trauma in young, working-age population.

LIMITATIONS OF THE STUDY

One limitation is the relatively modest sample size, which may affect the generalizability of the findings to broader populations. Another limitation lies in the study's observational design, which, while useful for identifying associations, cannot establish causality between specific fracture patterns and long-term ocular outcomes. The absence of a control group and potential selection bias—where patients presenting to a tertiary care center may differ from those in community settings—could also influence the results. Additionally, the study primarily focuses on short- to mid-term outcomes, and longer follow-up periods are needed to assess the durability of visual recovery and the incidence of late complications such as glaucoma or cataract formation.

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