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RADIOLOGICAL AND CLINICAL MANIFESTATIONS OF ORBITAL TRAUMA

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ABSTRACT

Background: Orbital fractures are a common subset of craniofacial trauma, with patterns and causes varying by age, gender, and mechanism of injury. Understanding these patterns is essential for timely diagnosis and optimal management. **Methods and Materials:** A retrospective descriptive study was conducted at Al-Mouwasat University Hospital over two years. A total of 504 patient records with radiologically confirmed orbital fractures were reviewed. Data were analyzed using descriptive statistics, including frequencies and percentages. **Results:** Only 3.4% of orbital fractures were isolated, while 66% were associated with other facial fractures. The most affected age group was 40–50 years, with a female predominance. Bilateral orbital fractures were most common (45.1%), and left-sided fractures were more frequent than right-sided ones. Domestic injuries accounted for 48% of cases, followed by traffic and swimming pool incidents. Orbital floor fractures were the most frequent (47%), and a significant proportion of cases involved globe injury or muscle entrapment. **Conclusion:** Orbital fractures exhibit distinct epidemiological and anatomical patterns, strongly influenced by age and injury context. These findings support the need for age-targeted prevention and prompt multidisciplinary evaluation.

KEYWORDS: Orbital fractures, Facial trauma, Epidemiology, Injury mechanism.

INTRODUCTION

Orbital trauma is a frequent and potentially vision-threatening injury that can result from blunt, penetrating, or blast-related mechanisms. Given the anatomical complexity of the orbit and its proximity to critical neurovascular and ocular structures, prompt diagnosis and management are essential to preserve function and prevent complications. Clinical manifestations vary depending on the mechanism and severity of trauma, ranging from periocular ecchymosis and diplopia to severe globe rupture and optic neuropathy.[1, 2]

Radiological imaging plays a pivotal role in the evaluation of orbital trauma. Computed tomography (CT) is considered the gold standard in the acute setting due to its superior ability to delineate bony fractures, detect foreign bodies, and assess for associated intracranial or maxillofacial injuries.[3, 4] Magnetic resonance imaging (MRI), while less commonly used acutely, provides complementary soft tissue detail and is especially useful in evaluating optic nerve injuries or orbital apex syndromes.[5]

A comprehensive understanding of both the radiological and clinical features of orbital trauma is crucial for guiding timely intervention, determining prognosis, and minimizing long-term morbidity.[6, 7]

METHODS AND MATERIALS

Study Design and Setting

This was a retrospective descriptive study conducted in the Department of Oral and Maxillofacial Surgery at Al-Mouwasat University Hospital in Damascus, one of the largest tertiary teaching centers in Syria. The aim was to describe the clinical and anatomical patterns of orbital fractures and identify the most common associated features.

Study Period and Sample

The study included all patients diagnosed with orbital fractures who were admitted to Al-Mouwasat Hospital between January 2022 and December 2023. Data were collected from paper files and the hospital's electronic archive, with a total of 504 patients included in the study.

Data Collection

A structured data collection form was designed to extract the following variables from patient medical records:
Age
Gender

Mechanism of trauma
Side of injury
Type of fracture (floor, medial wall, roof, combined or complex)
Associated ocular, nerve, or extraocular muscle injuries
Involvement of adjacent sinuses (e.g., maxillary sinus)
Presence of midface complex fractures (e.g., quadripod or zygomaticomaxillary complex fractures)

Inclusion Criteria
Patients of both sexes
Age greater than one year
Radiologically confirmed orbital fracture (CT or plain X-ray)
Complete clinical and imaging data available in the medical records

Exclusion Criteria
Cases lacking adequate radiological documentation of the fracture pattern
Patients with orbital fractures due to neoplastic or non-traumatic pathological causes
Incomplete essential data (e.g., age, gender, trauma mechanism, radiological findings)

Ethical Approval
This study was approved by the Ethics Committee of Al-Mouwasat University Hospital, under approval number: 4013/M.M/D. All patient data were handled in accordance with the Declaration of Helsinki, ensuring confidentiality and anonymity.

Statistical Analysis
Only descriptive statistical analysis was performed. Categorical variables were expressed as frequencies and percentages. Results were presented in both narrative and tabular formats to illustrate distributions by gender, age groups, anatomical patterns, and trauma mechanisms.

RESULTS

The findings of the study showed that isolated orbital fractures represent a small proportion of all facial trauma cases (3.4%). However, orbital involvement within the context of midface fractures was significantly more common, accounting for 54.3% of cases. Among the 504 patients with orbital fractures included in the study, 66% had associated facial fractures, while only 34% had isolated orbital fractures.

Temporal and Demographic Distribution
A long-term epidemiological study from the United States demonstrated a marked increase in orbital injuries over the past decade, with incidence rising from 61.3 per million people in 2013 to 133.0 in 2022. This increase was especially noted among the elderly population.

Regarding age distribution, a bimodal peak was observed: the highest rates occurred among individuals aged 18–64 years (37%), followed by smaller peaks in those under 20 and over 80 years. The most affected age group was 40–50 years (40%), while the least affected was the 11–20 age group (5%).

In terms of gender, women were found to be more frequently affected than men, particularly in the 40–50-year age group (40%). Some of these injuries may be linked to domestic violence or age-related anatomical and physiological changes.

Lateral Distribution and Etiology
There was a clear difference in lateral distribution, with left-sided fractures being more common (36.9%) than right-sided ones (18%), while bilateral fractures were the most prevalent overall (45.1%). This pattern may be attributed to the predominance of right-handed individuals during physical assaults, which commonly results in injuries to the victim's left side.

Injury Environment
Domestic accidents were the leading cause of orbital trauma (48%), followed by road traffic accidents and swimming pool incidents (18% each). In closed trauma cases, the proportion of home injuries decreased to 33%, while road traffic accidents increased to 27%, and assaults were responsible for 5%. For ocular-specific injuries, workplace injuries were notable (25%), along with 47.5% from home accidents and 13.8% from traffic-related events.

Anatomical Classification
With respect to anatomical classification, orbital floor fractures were the most common (47%), followed by combined fractures (floor and medial wall) at 30%, isolated medial wall fractures (18%), and roof fractures (5%).

Fracture Patterns by Age
Fracture patterns varied with age:
In the 0–6-year age group, floor fractures dominated (56%), followed by medial wall fractures (20%).

In children aged 7–12 years, floor fractures increased to 67%, while medial wall fractures declined.

Among adolescents aged 13–18 years, combined fractures became the most frequent (50%), while floor fractures declined to 42%, and lateral wall fractures were absent.

This shift is likely due to the progressive development and pneumatization of facial sinuses during childhood, which changes the biomechanical properties of facial bones and the pattern of fracture propagation.

Clinical Associations
A significant proportion of orbital fractures (30%) were associated with direct globe injury. Medial wall fractures specifically were associated with muscle edema (30%), hematoma (30%), and entrapment or avulsion of the medial rectus muscle in 30% of cases.

Distinct Fracture Mechanisms

A specific fracture pattern known as the "open door" fracture was observed in 60% of cases, 83% of which were accompanied by hemorrhagic contusions of the maxillary sinus. Additionally, zygomaticomaxillary complex fractures were frequently associated with maxillary sinus contusions (85%) and orbital floor fractures (86%). Another pattern, termed the "quadruple fracture", involved all four zygomatic sutures (zygomaticomaxillary, frontozygomatic, zygomaticosphenoidal, and zygomaticotemporal) in equal distribution.

DISCUSSION

The present study provides a comprehensive overview of orbital fracture patterns over a two-year period at a major tertiary care center in Syria. The results highlight that orbital fractures often occur in association with other facial fractures rather than in isolation. This observation is consistent with global literature indicating that orbital trauma frequently coexists with midfacial injuries, particularly zygomaticomaxillary complex (ZMC) and naso-orbito-ethmoidal (NOE) fractures.[8]

Incidence and Demographic Patterns

The relatively high incidence of orbital fractures in the 40–50-year age group is consistent with epidemiological studies from Western countries, where peak incidence has also been reported among middle-aged adults.[9] The bimodal distribution observed in our study mirrors findings by Rashid et al. (2020), who noted higher rates among both young adults involved in high-velocity trauma and elderly individuals experiencing low-impact falls.[10] The predominance of females in the 40–50 age group could suggest a possible contribution of domestic violence or hormonal and anatomical changes, which may render the orbital bones more susceptible to injury in this demographic—a hypothesis supported by Lee et al. (2016).[11]

Lateralization and Mechanism of Injury

The predominance of left-sided orbital fractures (36.9%) aligns with the global pattern attributed to right-handed assailants in interpersonal violence.[12] Bilateral involvement, however, being the most common pattern (45.1%), may reflect high-energy trauma, such as motor vehicle collisions or industrial accidents, known to result in more extensive facial injuries.[13]

The home as the leading location of trauma (48%) differs from reports in industrialized countries, where road traffic accidents and sports injuries often dominate.[14] This contrast likely reflects sociocultural differences, urban infrastructure, and the limited prevalence of organized sports in the local population.

Anatomical Distribution and Fracture Types

The orbital floor was the most frequently involved anatomical site (47%), consistent with the known anatomical weakness of the orbital floor due to its thin bony structure and proximity to the maxillary sinus.[15] This finding is in agreement with studies by Burnstine et al. and Pham et al., which both reported the floor as the most commonly fractured orbital wall.[16, 17]

Medial wall fractures, though less common (18%), were significantly associated with extraocular muscle complications, particularly medial rectus entrapment and edema. This finding mirrors results from a study by Tabrizi et al., who found a strong correlation between medial wall injuries and ocular motility dysfunction.[18]

Fracture Patterns Across Age Groups

Age-specific fracture patterns were noted, with floor fractures dominating in early childhood, while combined fractures became more prevalent in adolescence. This shift is likely due to ongoing pneumatization of the sinuses and structural maturation of the facial skeleton, as described in pediatric craniofacial studies by Zimmerman et al.[19] The absence of lateral wall fractures in adolescents may be due to the relative anatomical protection provided by the developing zygomatic arch in this age group.

Complex Fractures and Specific Mechanisms

The identification of "open door" and "quadruple" fracture patterns in this study adds to the spectrum of orbital injury mechanisms. The high prevalence of maxillary sinus contusions (83%) in cases of open-door fractures supports the concept that blowout-type mechanisms often involve sinus hemorrhage and wall displacement.[20] Similarly, the frequent co-occurrence of ZMC fractures with orbital floor involvement (86%) reinforces the functional and anatomical interdependence of midfacial buttresses and the orbital skeleton, as outlined by Frodel et al.[21]

Clinical Implications

The finding that 30% of orbital fractures were associated with direct globe trauma underscores the importance of thorough ophthalmologic evaluation in all cases of orbital trauma. This rate is higher than that reported in some Western studies, possibly due to delayed presentation or lack of protective equipment in high-risk occupations in the local setting.[22]

CONCLUSION

This study highlights the high prevalence and diverse clinical patterns of orbital fractures, with particular emphasis on the influence of age, gender, and trauma mechanism. The findings underscore the importance of early imaging and interdisciplinary evaluation in patients presenting with orbital trauma.

DECLARATIONS

Data Availability: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Conflict of Interest: The authors declare no conflict of interest.

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Authors' Contributions: Hiba Basher Hijazi and Sara Ahmad Namoze contributed equally to data collection and analysis. Khalid Khattab supervised the study design, statistical interpretation, and final manuscript revision.

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