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Assessment of orbital injury in the emergency department

İhsaniye Süer Doğan[1], Nezih Kavak[2], Ece Zengin[1], Behlül Atalay[1], Rasime Pelin Kavak[1], Nurettin Bayram[3]

[1]*Department of Radiology, Ankara Etlik City Hospital, Ankara, Turkiye*
[2]*Department of Emergency Medicine, Ankara Etlik City Hospital, Ankara, Turkiye*
[3]*Department of Ophthalmology, Ankara Etlik City Hospital, Ankara, Turkiye*

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ABSTRACT

Aims: Orbital injury is a significant clinical presentation in the emergency department (ED). This study aims to evaluate the clinical and radiological findings in patients presenting to the ED with orbital injury.

Methods: For patients who presented to the ED due to orbital injuries and underwent computed tomography scanning, data were recorded on age, gender, type of trauma, the presence of additional trauma locations (if any), the injured eye, the cause of injury, and the specific location of the injury.

Results: 314 patients were included in the study, with a mean age of 46.54±18.23 years (range: 18–79). Among these, 217 patients (69.1%) were male. Blunt trauma was observed in 202 patients (64.3%), and 102 patients (32.5%) sustained injuries as a result of road traffic accidents. Analysis of injury localization revealed that bone injuries were present in 202 patients (64.3%). Patients who experienced blunt trauma were significantly older ($p<0.001$). Individuals who suffered from falls from height and falls from the ground had higher mean ages compared to those with other injury types ($p<0.001$ for both comparisons). Patients involved in road traffic accidents were also found to be older than those with gunshot injuries ($p<0.05$). A gender-specific analysis indicated that, among females, road traffic accidents and falls from the ground were more prevalent, whereas males more frequently sustained gunshot injuries ($p<0.001$, $p<0.001$, and $p<0.001$, respectively). Additionally, anterior chamber injuries were significantly more common in male patients ($p<0.001$).

Conclusion: The analysis indicates that the types and etiologies of orbital injury vary according to the patients' ages, while the patterns of injury differ based on gender.

Keywords: Orbital injury, emergency department, computed tomography

INTRODUCTION

The orbit represents an intricate anatomical structure that integrates complex structural, vascular, and functional attributes. It is defined as the osseous cavity within the cranial vault that accommodates the globe and its ancillary tissues. Morphologically, the orbital cavity exhibits a conical configuration, delineated by the anterior and middle cranial base in conjunction with the viscerocranium. It is anatomically bounded by four distinct osseous walls—namely, the superior (roof), inferior (floor), medial, and lateral walls—which confer structural integrity and provide critical protection to the eye.[1] Encompassed within this cavity are various soft tissue components, including the globe, extraocular musculature, adipose compartments, and the lacrimal apparatus, which collectively facilitate ocular motility, provide biomechanical cushioning, and sustain the physiological functions of the visual system.[2]

Orbital trauma constitutes approximately 3% of all presentations in the emergency department (ED).[3] Blunt orbital trauma describes injuries inflicted upon the orbital region as a result of significant impact forces, frequently leading to fractures of the orbital walls. Conversely, penetrating orbital trauma involves injuries to the orbit that occur without direct compromise of the ocular globe, often resulting from the incursion of either blunt or sharp objects, with the former typically imparting more extensive structural damage.

Orbital injury encompasses injuries to the orbital cavity, a region characterized by its limited spatial dimensions and the presence of critical neurovascular and muscular structures. Such injuries may involve osseous fractures or soft tissue damage, potentially concluding in adverse outcomes such as visual impairment or dysfunction of the extraocular muscles. Additionally, the presence of foreign bodies into the orbital space can precipitate significant pathological sequelae. The prevalence and severity of orbital injury depends on by a variety of factors, including the patient's age, the etiological

Corresponding Author: İhsaniye Süer Doğan, dr.ihsaniye@gmail.com

mechanism of injury, and underlying socioeconomic determinants.

Efficient diagnosis and early therapeutic intervention are vital in the management of orbital injury. Radiographic evaluation is necessary for the conclusive diagnosis of orbital fractures. Currently, computed tomography (CT) is regarded as the gold standard in imaging, as it provides rapid, high-resolution details regarding the extent, and anatomical localization of orbital fractures, and associated soft tissue involvement, while also allowing comprehensive assessment of adjacent facial osseous structures for additional injuries.[4] The presence of orbital foreign bodies introduces significant diagnostic and therapeutic complexities, primarily owing to their often-subtle entry points. In these instances, CT imaging is critical, given its efficacy in identifying both metallic and non-metallic foreign materials.

The aim of the present study is to assess the clinical and radiological characteristics of patients presenting with orbital injury in the ED.

METHODS

The approval was granted by the Ministry of Health Ankara Etlik City Hospital Clinical Researches Ethics Committee (Date: 29.01.2025, Decision No: 2025/0185). The study was retrospective, consent was not obtained from the participants. The study was conducted following the Declaration of Helsinki.

A retrospective analysis was conducted on patients aged 18 years or older who underwent orbital CT or maxillofacial imaging, as requested from the ED, between November 1, 2022, and January 18, 2025. Patients who were not suitable for CT scan evaluation were excluded.

CT scans were carried out with multi-slice CT scanner systems (GE Revolution EVO, GE Medical Systems, Milwaukee, WI, USA). Images were acquired from the vertex to the base of the skull in helical mode (kVp 120, mAs 250) and reconstructed in the axial plane with 0.625 mm thickness.

For patients who presented to the ED due to orbital injuries and underwent CT scanning, data were recorded on age, gender, type of trauma, the presence of additional trauma locations (if any), the injured eye, the cause of injury, and the specific location of the injury.

Statistical Analysis

For continuous variables (e.g., age), descriptive statistics were calculated and reported as the mean±standard deviation, median, minimum, and maximum values. Discrete variables were summarized using frequency counts and percentages. The Kolmogorov–Smirnov test was employed to evaluate the normality of continuous data distributions. Comparisons of age across different trauma aetiologies were conducted using the Kruskal–Wallis variance analysis. For variables exhibiting statistically significant differences on the Kruskal–Wallis test, subsequent group-wise disparities were delineated via a Kruskal–Wallis multiple comparisons test. Furthermore, intergroup comparisons of age across trauma types were performed using the Mann–Whitney U test. The Chi-square test was applied for the comparative analysis of nominal variables presented in contingency tables. All statistical analyses were executed using IBM SPSS Statistics version 20 (Chicago, IL, USA), with a p-value of <0.05 considered indicative of statistical significance.

RESULTS

A total of 314 patients were included in the study. The cohort displayed a mean age of 46.54±18.23 years, with ages ranging from 18 to 79 years. Males comprised 69.1% (n=217) of the sample population. Blunt trauma was identified in 64.3% (n=202) of cases, whereas road traffic accidents were responsible for injuries in 32.5% (n=102) of patients. Additionally, 55.1% (n=173) of the patients sustained injuries to the right eye (Table 1).

Table 1. Patient demographic and epidemiologic variables and their categories

	n	%
Gender		
Female	97	30.9
Male	217	69.1
Trauma type		
Blunt	202	64.3
Penetrating	112	35.7
Concomitant trauma		
Absent	271	86.3
Present	43	13.7
Injured eye		
Right	173	55.1
Left	124	39.5
Bilateral	17	5.4
Trauma mechanism		
Road traffic accident	102	32.5
Occupational injury	23	7.3
Gunshot injury	90	28.7
Fall from height	21	6.7
Fall from ground	64	20.4
Violence	14	4.5

In the distribution of injury localizations among patients, osseous injuries were identified in 202 cases (64.3%), with the orbital floor being the most commonly affected site, noted in 79 patients (39.1%) (Table 2).

Frequency and percentage values represent the proportion of patients relative to the total sample size. Some patients sustained multiple traumas, resulting in a total number of injuries that exceeds the number of patients.

Patients presenting with blunt trauma were significantly older (p<0.001). Furthermore, individuals who sustained injuries from falls from height or falls from the ground exhibited significantly higher ages compared to those with other injury mechanisms (p<0.001 for both comparisons). Additionally,

Table 2. Distribution of injury localizations among patients

	n	%
Bone		
Absent	112	35.7
Present	202	64.3
Bone type (n=202)		
Floor	79	39.1
Medial wall	51	25.2
Roof	40	19.8
Mix	23	11.4
Lateral wall	9	4.5
Anterior chamber		
Absent	203	64.6
Present	111	35.4
Globe		
Absent	239	76.1
Present	75	23.9
Intraconal orbit		
Absent	268	85.4
Present	46	14.6
Optic nerve		
Absent	296	94.3
Present	18	5.7
Extraocular muscles/ extraconal orbit		
Absent	292	93.0
Present	22	7.0

Due to some patients having multiple injuries, the total number of traumas was higher than the number of patients. Frequency and percentage values show the ratio of patients and the total number of patients.*

patients with road traffic accidents demonstrated a higher mean age relative to those who experienced gunshot injuries (p<0.05) (Table 3).

Table 3. Comparison of patient ages across trauma types and aetiologies

	Age		
	Mean±SD	**Median (min- max)**	**p value**
Trauma type			
Blunt	52.53±17.77	61 (18-79)	<0.001[b]
Penetrating	35.75±13.51	31 (18-66)	
Trauma mechanism			
Road traffic accident	45.15±18.36	47.5 (18-75)	<0.001[d]
Occupational injury	34.83±7.64	33 (24-48)	
Gunshot injury	35.81±14.26	31 (18-66)	
Fall from height	64.76±3.63	65 (60-77)	
Fall from ground	65.94±4.14	66 (59-79)	
Violence	29.00±3.65	28 (22-38)	

b: Mann-Whitney U test, d: Kruskal-Wallis variance analysis, SD: Standard deviation

Among female patients, the incidence of road traffic accidents and falls from the ground were significantly elevated, whereas male patients were more frequently affected by gunshot injuries (p<0.001 for all comparisons) (Table 4).

Table 4. Comparative analysis of trauma types and mechanisms according to gender

	Female		Male		
	n	**%**	**n**	**%**	**p value**
Trauma type					
Blunt	83	85.6	119	54.8	<0.001[c]
Penetrating	14	14.4	98	45.2	
Trauma mechanism					
Road traffic accident	48	49.5	54	24.9	<0.001[c]
Occupational injury	0	0	23	10.6	
Gunshot injury	14	14.4	76	35.0	
Fall from height	5	5.2	16	7.4	
Fall from ground	28	28.9	36	16.6	
Violence	2	2.1	12	5.5	

c: Chi-Square test /Fisher's Exact test

Anterior chamber injuries were significantly more widespread among male patients (p<0.001), while female patients exhibited a higher frequency of injuries involving osseous structures, the globe, the intraconal orbital space, the optic nerve, muscular tissues, and extraocular muscles within the extraconal orbital space (with corresponding p-values of p<0.001, p=0.05, p<0.01, p<0.01, p<0.01, and p<0.05, respectively) (Table 5, Figure 1 a,b,c,d,e,f).

Table 5. Comparative analysis of orbital injury findings between female and male patients

	Female		Male		p value
	n	**%**	**n**	**%**	
Bone	83	85.6	119	54.8	<0.001[c]
Anterior chamber	12	12.4	99	45.6	<0.001[c]
Globe	30	30.9	45	20.7	0.050[c]
İntraconal orbit	22	22.7	24	11.1	0.007[c]
Optik nerve	11	11.3	7	3.2	0.004[c]
Extraocular muscles/ extraconal orbit	12	12.4	10	4.6	0.013[c]

c: Chi-Square test

Traumatic brain injury was observed in 43 patients (13.7%) (Figure 2 a,b).

DISCUSSION

Orbital injury represents a critical medical issue due to its potential to inflict substantial and long-term damage on both the anatomical integrity and functional capacity of the eye and adjacent structures. The ED serves as the primary setting for the initial evaluation, diagnosis, and acute management

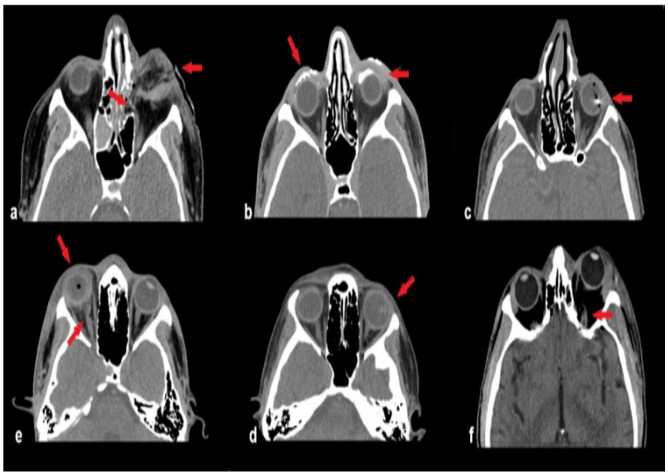

Figure 1. In the axial computed tomography examinations, a disorganized globe, left extraconal and intraconal heterogeneous density and millimetric air values were observed. Left medial rectus muscle is not observed (**a**), foreign body intensities are observed in bilateral preseptal areas (**b**), the millimetric metallic foreign body is observed in the left globe (**c**), deformation, haemorrhagic intensities, and millimetric air density are observed in the right globe. Loss of integrity and millimetric air densities are observed in the right optic nerve (**e**), the lens is not observed on the left, but it is observed in the vitreous fluid (**d**), and loss of integrity is observed in the left optic nerve (**f**) (red arrows to all)

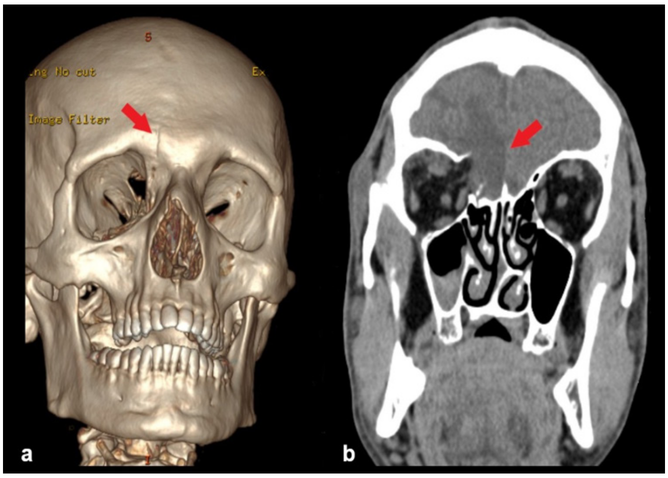

Figure 2. In the 3D computed tomography scan, fracture lines are observed in the medial orbital wall on the right (**a**), and in the coronal section, densities consistent with oedema and haemorrhage are observed in the right frontal brain parenchyma at this level (**b**) (red arrows)

of such injuries. CT remains the imaging modality of choice, given its advanced sensitivity in identifying orbital fractures, associated soft tissue damage and foreign bodies.

The financial burden associated with orbital injury has increased considerably over time, with ED expenditures rising substantially, highlighting the necessity for targeted preventive measures to reduce healthcare costs and enhance clinical outcomes. Epidemiological data indicate a marked increase in the incidence of orbital injuries, particularly blunt trauma, over the study period, with cases rising from 61.3 per million person-years in 2013 to 133.0 per million person-years in 2022.[5]

Blunt orbital trauma is recognized as a predominant contributor to ocular injuries, with its aetiology demonstrating considerable variation across diverse populations. Individuals from lower socioeconomic strata appear to be at a higher risk, likely due to increased exposure to environments where the incidence of violence and accidents is higher.[6]

Motor vehicle accidents are frequently implicated as a principal cause of blunt orbital trauma, a phenomenon that is particularly pronounced in urban areas characterized by high traffic density.[7] Within the spectrum of trauma mechanisms, falls and assaults have been most commonly reported. In a prospective investigation, al-Qurainy et al.[8] documented those assaults accounted for 49.9% of cases, whereas falls and motor vehicle accidents comprised 19% and 12.4% of incidents, respectively—a pattern corroborated by a more recent study by Chow et al.[9], which reported figures of 48%, 17%, and 21% for assault, falls, and motor vehicle accidents, respectively.[8,9] Conversely, Amrith et al.[10] identified motor vehicle accidents as the largest proportion of cases at 36.5%, with assaults representing 12.5%. Furthermore, another study observed blunt trauma as the contributing factor in 48.3% of cases, with falls and motor vehicle accidents accounting for 24.3% and 25.4% of cases, respectively.[11]

In this study, blunt trauma emerged as the most frequently observed injury, with motor vehicle accidents representing the main etiological factor. Given the variability observed among studies with adequate sample sizes, these inconsistencies are likely due to regional and cultural influences.[11]

Young adults, particularly males aged 20–29, demonstrate an elevated exposure to ocular injuries, a phenomenon largely attributable to their dynamic lifestyles and active participation in sports and physical activities. This cohort is predisposed to sustaining injuries from blunt impacts, with a considerable number of cases occurring in domestic and commercial environments. Additionally, the incidence of ocular injury in this demographic is further exacerbated by occupational hazards, especially within industrial settings where the use of protective eyewear remains insufficient.[12]

In contrast, the elderly population experiences the highest incidence of orbital trauma, primarily as a consequence of falls, which represent the major reason of injury in this age group. In this study, similarly, the frequency of falls was significantly higher among older individuals compared to other age cohorts. Implementation of comprehensive fall prevention strategies and the integration of safety-enhancing features in residential design may be fundamental in reducing the rising rates of orbital trauma in the elderly.[5]

Moreover, the results revealed that road traffic accidents and ground-level falls were more prevalent among female patients, whereas gunshot injuries were more frequently encountered in male patients. Epidemiological studies display consistent male predominance in orbital trauma cases. For instance, a study conducted at a London trauma centre documented that 82% of patients with orbital fractures were male.[12] Furthermore, a retrospective review at Ahmadu Bello University Teaching Hospital identified 142 patients with orbital/ocular trauma over a two-year period, yielding a male-to-female ratio of 3:1, thereby highlighting the higher incidence of these injuries in males.[13]

Within the geriatric cohort, our findings indicated a higher prevalence of females compared to males, whereas males predominated in all other age groups. This observation is consistent with prior research, which has documented an increased susceptibility among elderly females to falls and maxillofacial trauma—a trend that may be partly explained by the significant female representation within this population.[14]

Moreover, males are excessively represented in high-risk occupational sectors such as construction, metalworking, and agriculture, which are inherently associated with an elevated incidence of ocular injuries. These professions frequently involve exposure to hazards including airborne debris, chemical agents, and heavy machinery, thereby amplifying the risk of ocular injury. Additionally, tendency among men to underestimate the risks inherent in their work environments often results in diminished compliance with established safety protocols.

Men display a higher susceptibility to orbital injury than women due to a complex interplay of biological, sociocultural, and environmental factors. The elevated incidence of orbital injuries in men is largely a consequence of increased exposure to risk determinants, such as interpersonal violence and occupational hazards. In particular, males living in socioeconomically disadvantaged areas face an increased risk of assault-related orbital injury. Socioeconomic variables—including poverty, unemployment, and lower educational attainment—are associated with higher injury rates, as these factors frequently correspond with increased crime and violence, thereby contributing to the gender difference observed in orbital trauma incidence.[15,16]

Orbital injury in the adult population remains a critical clinical issue due to its potential to result in severe ocular and facial injuries. Multislice CT combined with three-dimensional reconstructions has proven effective in accurately assessing the extent of orbital fractures and identifying associated complications.

Orbital trauma resulting in osseous fractures constitutes a significant concern in maxillofacial injuries, frequently arising from direct impacts to the periorbital region or the adjacent facial bones. Such fractures can lead to both functional deficits and cosmetic deformities. In the study conducted by Goelz et al.[17], the orbital floor was involved in 165 patients (66.8%), establishing it as the most widespread fracture position. Conversely, another study identified the lateral orbital wall as the most commonly fractured region, with 105 patients (71.43%) sustaining fractures in this area, while the orbital floor ranked as the second most frequent site, affecting 55 patients (37.42%).[18] In this study, osseous fractures were most frequently observed in the lateral orbital wall, followed by the orbital floor. Although the lateral wall is the most rigid among the orbital walls, its distinct anatomical position renders it particularly susceptible to direct traumatic impacts, especially in cases of midfacial trauma resulting from road traffic accidents and falls.[18] In the study cohort, road traffic accidents, and falls were identified as the principal etiological factors for trauma.

In this study, anterior chamber injuries were significantly more frequent among male patients. Previous investigations have demonstrated that blunt ocular trauma—which often involves the anterior chamber—mainly affects men, with 82% of reported cases occurring in this population.[19] This high incidence among males can be attributed to their heightened exposure to high-risk activities and environments, including certain occupational settings and sports.

Optic nerve injury may occur via both direct and indirect mechanisms. Direct trauma arises when the optic nerve is physically compromised by penetrating injuries, such as those induced by foreign bodies or osseous fragments, leading to shearing forces or the formation of a hematoma within the nerve.[20,21]

Indirect injuries to the optic nerve arise from force, typically due to blunt trauma, which can lead to deformation of the optic canal and subsequent damage to the nerve. This mechanism, termed indirect traumatic optic neuropathy, occurs as forces transmit through the skull and adversely affect the optic nerve.[21,22] In this study, optic nerve injury was the least frequently observed among the evaluated injuries.

Additionally, traumatic brain injury was present in 13.7% of patients. The coexistence of polytrauma, including traumatic brain injuries, often complicates the management of orbital injuries, underscoring the necessity for a coordinated, multidisciplinary approach. Such brain injuries can exacerbate the clinical consequences of orbital trauma, increasing the risk of neurological deficits and subsequent infections.[23]

Limitations

Several limitations of this study must be acknowledged. The retrospective, single-centre design restricts the generalizability of our findings, and the exclusion of patients with minor injuries who did not undergo CT imaging may introduce selection bias, potentially expanding the apparent occurrence and severity of orbital injury. Future research should focus on prospective, multicentre studies with broader inclusion criteria to validate these observations and to further elucidate the epidemiological and clinical nuances of orbital injuries, thereby informing more effective clinical interventions and preventive measures.

CONCLUSION

In conclusion, orbital injury represents a critical and multifaceted clinical challenge in the ED, with significant implications for both ocular function and facial integrity. Our study, which encompassed a diverse patient cohort, demonstrates that the incidence, type, and aetiology of orbital injuries vary markedly with age and gender. Blunt trauma emerged as the predominant mechanism, particularly in older populations and in association with falls, whereas high-risk activities and occupational exposures contributed substantially to the burden of injuries observed in younger male patients. Additionally, the frequent occurrence of concomitant injuries, including traumatic brain injury, underscores the complexity of managing these patients and highlights the necessity for a coordinated, multidisciplinary approach.

ETHICAL DECLARATIONS

Ethics Committee Approval

The approval was granted by the Ministry of Health Ankara Etlik City Hospital Clinical Researches Ethics Committee (Date: 29.01.2025, Decision No: 2025/0185).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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