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Epidemiological characteristics of intracranial pathologies and their association with fracture patterns in maxillofacial trauma: a retrospective cohort study

Sezin Bozkurt[1], Mehmet Özgür Erdoğan[2], Kadir Yenal[1]

[1]Department of Emergency Medicine, Ankara Bilkent City Hospital, Ankara, Turkiye

[2]Department of Emergency Medicine, Bakırköy Dr. Sadi Konuk Training and Research Hospital, İstanbul, Turkiye

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Corresponding Author: Sezin Bozkurt, dr.sezinbzkrt@gmail.com

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ABSTRACT

Aims: This study aimed to investigate the epidemiological characteristics of intracranial pathologies associated with maxillofacial trauma, and to examine their relationship with fracture types.

Methods: This retrospective cohort study included a total of 1.048 patients who presented to the Emergency Department of Haydarpaşa Training and Research Hospital between 2012 and 2014. Demographic data, trauma mechanisms, seasonal distribution and fracture localisations were evaluated. The presence of intracranial pathology was determined based on computed tomography (CT) findings.

Results: The mean age of the patients was 34.7 years, with a predominance of males. No significant association was found between age, sex and cerebral injury. Fractures of the maxilla, zygoma, frontal sinus and orbit were significantly associated with intracranial pathology ($p<0.05$). Cerebral injury was observed in 16.17% of cases of nasal fracture, 41.48% of cases of frontal sinus fracture, and 50.00% of cases of orbital roof fracture. Seasonal analysis revealed that cerebral injuries were most frequently observed during spring and autumn. Falls were the most common cause of trauma, followed by traffic accidents.

Conclusion: Maxillofacial fractures, particularly those involving the midface and frontal regions, are important risk factors for cerebral injury. The predominance of simple falls as the leading cause and the higher frequency of injuries in autumn emphasise the importance of considering regional epidemiological patterns in trauma management.

Keywords: Maxillofacial trauma, intracranial pathology, fracture patterns, epidemiology, emergency medicine

INTRODUCTION

Nowadays, facial injuries constitute a significant proportion of emergency department visits. Global epidemiological data reveal that road traffic crashes are the leading etiological factor, particularly in low- and middle-income countries, followed by interpersonal violence and occupational accidents. In addition, assaults, falls, sports injuries, and other occupational accidents are also reported at significant rates. Geographical differences in trauma distribution are emphasised as being closely related to socio-cultural and environmental factors.[1]

The incidence of maxillofacial fractures worldwide increased by 19% between 1990 and 2019. This increase is reported to be more pronounced in males, with fractures due to falls increasing steadily in the elderly population.[2] In a review conducted by Adeleke et al.[3] in Sub-Saharan Africa, it was shown that maxillofacial injuries most commonly occur as a result of road traffic accidents (mostly motorcycle-related) and assaults; the incidence is significantly higher in males, and fractures are concentrated in the mandible and midface region. Similarly, studies conducted in different regions have reported that the distribution of maxillofacial trauma varies depending on geographical and socioeconomic conditions, with traffic accidents being the predominant cause in some regions and assault or falls being more prominent in others.[4,5]

Therefore, elucidating the etiology, distribution, and clinical outcomes of maxillofacial trauma; comparing the epidemiological characteristics of cases based on the presence of cerebral injury; and effectively managing diagnostic and treatment processes are of great importance.

METHODS

Ethics

Ethics committee approval is not required for retrospective patient file reviews that do not involve direct patient intervention or identification. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Study Design and Patient Selection

This study was designed as a retrospective cohort study. The medical records of patients who presented to the Emergency Department of Haydarpaşa Training and Research Hospital between 1 January 2012 and 31 December 2014 and were diagnosed with maxillofacial trauma were reviewed.

Inclusion criteria were defined as being over 16 years of age, having a diagnosis of facial fracture or soft tissue injury related to trauma, having a cranial computed tomography (CT) scan, and having complete medical records. Patients who presented for non-traumatic reasons, had incomplete records, or had a history of previous facial surgery were excluded from the study (**Figure 1**).

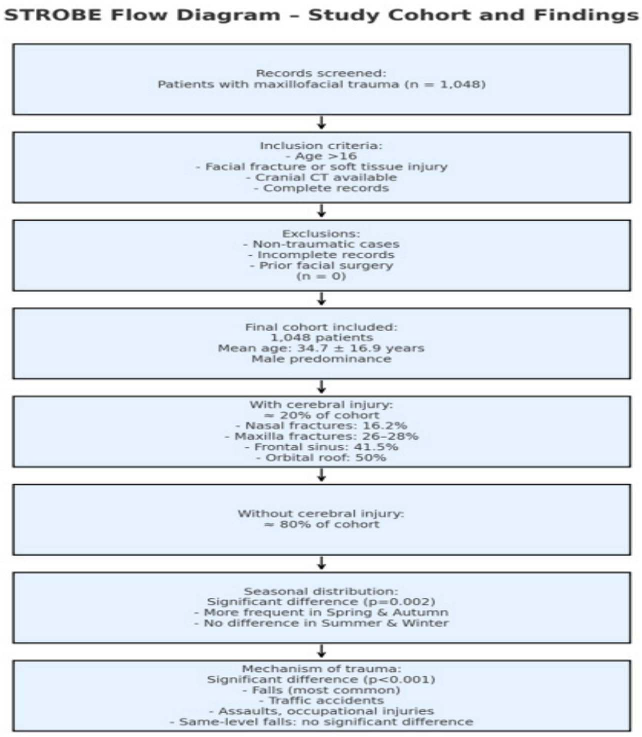

Figure 1. Strobe flow diagram

Variables

Demographic characteristics (age, gender), trauma mechanism, time of trauma (season: spring, summer, autumn, winter), and injury sites were recorded for all cases.

Facial fractures were classified as nasal, maxillary (right/left), mandibular (body, condyle, symphysis), zygomatic arch, zygomatic fracture, frontal sinus, and orbital fractures (lateral, roof, floor).

Patients were divided into two groups based on the presence of cerebral injury. Cerebral injury was defined as the presence of intracranial haemorrhage (epidural, subdural, subarachnoid, intraparenchymal), contusion, or diffuse axonal injury on CT.

Outcomes

The primary outcome was defined as determining the relationship between the presence of cerebral injury and demographic characteristics, trauma time, trauma mechanisms, and fracture locations.

Statistical Analysis

Data were analysed using SPSS v.28 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean±standard deviation; Independent samples t-test was used for intergroup comparisons. Categorical variables were expressed as numbers (%) and Pearson Chi-square test was applied for comparisons. Post hoc subgroup analyses were conducted to evaluate the source of differences in variables found to be statistically significant. The significance level was set at $p<0.05$.

RESULTS

The mean age of the total 1.048 patients included in the study was 34.73±16.95 years (**Table 1**). No significant relationship was found between age and cerebral injury (p=0.169). When gender distribution was examined, cerebral injury was found in 21.0% of females and 19.4% of males; this difference was not statistically significant (p=0.636).

When evaluated according to fracture locations (**Table 1** and **Figure 2**);

- Nasal fractures were associated with cerebral injury in 16.18% of cases (p=0.035).
- Cerebral injury was detected in 26.38% of patients with left maxillary fractures (p=0.042) and in 27.70% of patients with right maxillary fractures (p=0.01).
- Mandibular body fractures had a 8.66% rate, mandibular condylar fractures had a 5.49% rate, and mandibular symphyseal fractures had no cerebral injuries ($p<0.001$ for all comparisons).
- Zygomatic arch fractures had a cerebral injury rate of 13.58%, while zygomatic fractures had a rate of 27.61% (p=0.032 and p=0.02, respectively).
- The rate of cerebral injury in cases of frontal sinus fractures was 41.48% ($p<0.001$),
- While it was 50.0% in orbital roof fractures ($p<0.001$).
- No significant relationship was found between age and gender variables and lateral orbital (26.58%) and orbital floor (18.66%) fractures ($p>0.05$).

Statistically significant differences were found in the frequency of cerebral injury according to seasonal distribution (p=0.002). Post hoc subgroup analyses revealed that this difference was particularly evident in the spring and autumn months ($p<0.05$). No significant difference was found between the groups in the summer and winter seasons (**Table 2**).

An evaluation based on trauma mechanisms also revealed a significant association with cerebral injury ($p<0.001$). Post hoc analyses revealed that the significant difference originated from the groups of falls from a height, traffic accidents, assault, syncope, collision with an object, and work-related accidents (**Table 3** and **Figure 3**). However, no statistically significant difference was found in the fall from the same level group ($p>0.05$).

Table 1. Demographic characteristics and distribution of cerebral injury according to facial fracture sites

Variable	Total (n, %)/mean (SD)	Serebral injury		p-value/difference (95% CI)
		No	With	
Age (years)	34.73 (16.95)	34.34 (16.38)	36.32 (19.04)	0.169/-4.81- 0.84*
Sex				
Female	224 (21.37%)	177 (79.01%)	47 (20.98%)	0.636**
Male	824 (78.62%)	664 (80.58%)	160 (19.41%)	
Fracture site				
Nasal	371 (35.40%)	311 (83.82%)	60 (16.17%)	0.035**
Left maxilla	144 (13.74%)	106 (73.61%)	38 (26.38%)	0.042**
Right maxilla	148 (14.12%)	107 (72.29%)	41 (27.70%)	0.01**
Mandibular corpus	127 (12.11%)	116 (91.33%)	11 (8.661%)	<0.001**
Mandibular condyle	91 (8.683%)	86 (94.50%)	5 (5.494%)	<0.001**
Mandibular symphysis	62 (5.916%)	62 (100%)	0 (0%)	<0.001**
Zygomatic arch	162 (15.45%)	140 (86.41%)	22 (13.58%)	0.032**
Zygomatic	134 (12.78%)	97 (72.38%)	37 (27.61%)	0.02**
Frontal sinus	135 (12.88%)	79 (58.51%)	56 (41.48%)	<0.001**
Orbital lateral wall	79 (7.538%)	58 (73.41%)	21 (26.58%)	0.14**
Orbital roof	40 (3.816%)	20 (50%)	20 (50.00%)	<0.001**
Orbital floor	75 (7.156%)	61 (81.33%)	14 (18.66%)	0.881**

SD: Standard deviation, CI: Confidence interval, * Independent sample t test, mean (SD), **Pearson Chi-square, n (%)

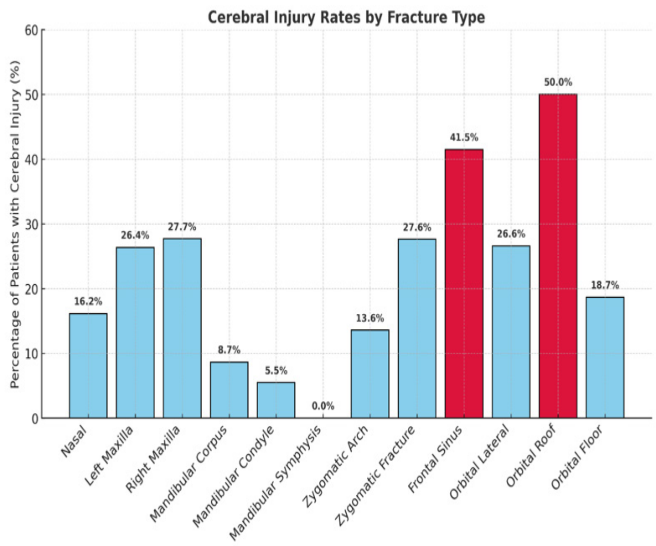

Figure 2. Cerebral injury types by fracture type

Table 2. Distribution of cerebral injury according to seasons

Season	Total n (%)	Serebral injury		p-value
		No	With	
Spring	289 (27.57%)	253 (87.54%)	36 (12.45%)	
Summer	243 (23.18%)	188 (77.36%)	55 (22.63%)	
Autumn	283 (27.00%)	214 (75.61%)	69 (24.38%)	0.002
Winter	233 (22.23%)	186 (79.82%)	47 (20.17%)	

Pearson Chi-square, n (%)

Table 3. Distribution of cerebral injury according to mechanisms of trauma

Mechanism of trauma	Total n (%)	Serebral injury		p-value
		No	With	
Same-level fall	286 (27.29%)	234 (81.81%)	52 (18.18%)	
Fall from height	65 (6.202%)	25 (38.46%)	40 (61.53%)	
Traffic accident	176 (16.79%)	110 (62.5%)	66 (37.5%)	
Assault	250 (23.85%)	221 (88.4%)	29 (11.6%)	
Syncope	83 (7.919%)	74 (89.15%)	9 (10.84%)	<0.001
Object-related injury	141 (13.45%)	133 (94.32%)	8 (5.673%)	
Occupational accident	47 (4.484%)	44 (93.61%)	3 (6.382%)	

Pearson Chi-square, n (%)

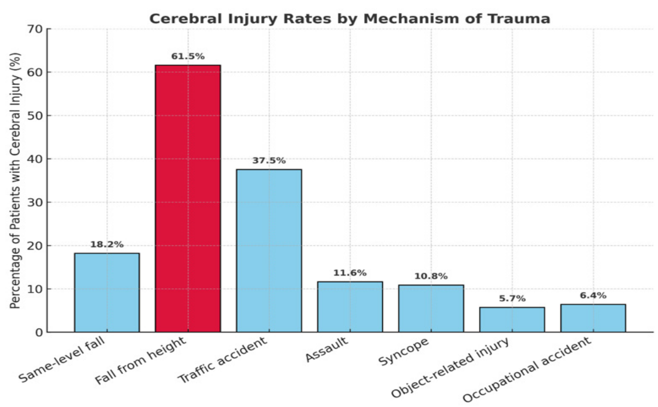

Figure 3. Cerebral injury rates by mechanism of trauma

DISCUSSION

Maxillofacial trauma is a clinical condition associated with serious morbidity and mortality, showing regional differences in aetiology and epidemiology. The literature emphasises that these injuries are closely related to intracranial pathologies. In our study, we demonstrated that fractures of the maxilla, zygoma, frontal sinus, and orbit are significantly associated with cerebral injuries.

It is consistently emphasised in the literature that maxillofacial trauma is most common in young adult males. The average age of approximately 35 and the predominance of males in our study support this general trend. Asya et al.[6] reported that the incidence of trauma was highest in the 19–28 age group, with male patients being four times more affected than females. Similarly, Xiao-Dong et al.[7] reported an average age of 36.1 years, with the highest rate in the 20–29 age group and men being three times more affected than women. These findings indicate that the demographic results of our study are consistent with the data in the literature.

Seasonal distribution varies across different geographical regions. Gassner et al.[8] reported that maxillofacial injuries are most common during the summer months. Similarly, Işık et al.[9] reported that head injuries in the paediatric population occur most frequently during the summer season. In a study conducted in India, it was noted that trauma rates were higher during the monsoon season (July–October) compared to summer and winter.[10] In contrast, in our study, it is noteworthy that cerebral injuries were most common in autumn. This may be related to the decrease in population density in the region during the summer months and its increase in autumn.

When examining trauma mechanisms, Roccia et al.[11] reported that maxillofacial fractures most commonly resulted from falls from the same level ('slipping, tripping or stumbling').

A large-scale analysis conducted in 2019 also reported falls as the most common cause globally, but showed that assault and violence-related trauma were more prevalent in young adults.[12] The close relationship between maxillofacial trauma and traumatic brain injury (TBI) has also been demonstrated in many studies.

Suprabha et al.[13] noted that maxillofacial injuries are an important risk factor for TBI in paediatric patients. T V et al.[14] reported a significant association between maxillofacial trauma and brain injury in adults with multiple trauma. A multicentre study published in 2025 emphasised that this relationship is particularly pronounced in fractures of the midface and frontal region.[15] Additionally, it has been demonstrated that the presence of head and neck injuries increases the risk of TBI development.[16] Tung et al.[17] reported that life-saving interventions were required in 64 patients (6.2%) with facial fractures, with cerebral injuries being the most common cause of these interventions. Our findings also indicate that cerebral injuries are significantly associated and consistent with the literature.

Our study has revealed the relationship between maxillofacial trauma and cerebral injuries from a regional perspective. Our findings indicate that etiological causes and seasonal distributions may vary according to social conditions. The fact that simple falls are the most common trauma mechanism and that injuries are more frequent in autumn are important observations specific to the region where our study was conducted. When data from different geographical regions are also considered, it can be concluded that the separate evaluation of epidemiological parameters at the regional level is of great importance for the development of accurate diagnosis, treatment, and preventive approaches.

Limitations

This study has several limitations that should be considered when interpreting the findings.

First, the retrospective design inherently carries the risk of incomplete or missing data, which may have influenced the accuracy of recorded variables such as trauma mechanisms or associated comorbidities. In addition, CT scans were interpreted based on available medical records without standardized re-evaluation, which might have introduced variability in detecting cerebral injuries.

Second, the study was conducted in a single tertiary referral center, which may limit the generalizability of the results to other regions with different epidemiological, social, or cultural characteristics. Regional factors such as seasonal population density changes and trauma-related healthcare-seeking behavior may have contributed to the distribution observed in this cohort and may not reflect broader national or global patterns.

Third, although the sample size was relatively large, the subgroups for specific fracture localizations (e.g., orbital roof, mandibular symphysis) were small. This may have affected the statistical power to detect subtle associations, and thus, the reported rates should be interpreted with caution.

Finally, the study did not assess long-term outcomes, treatment modalities, or functional prognosis of patients with cerebral injuries. Therefore, the clinical implications of the identified associations remain limited to the acute diagnostic phase.

Future multicenter, prospective studies with standardized imaging review and long-term follow-up are warranted to validate and extend our findings.

CONCLUSION

This study revealed that maxillofacial trauma, especially fractures of the maxilla, zygoma, frontal sinus, and orbit, were significantly associated with cerebral injuries. Our findings also showed that simple falls were the most common etiological cause in the region where the study was conducted and that cerebral injuries were most frequently seen in autumn.

These results suggest that considering regional epidemiological data in the management of maxillofacial trauma could provide important contributions to diagnosis, treatment, and preventive strategies.

ETHICAL DECLARATIONS

Ethics Committee Approval

Ethics committee approval is not required for retrospective patient file reviews that do not involve direct patient intervention or identification.

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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