

# Epidemiology of Craniofacial Injuries in a Tertiary University Hospital in Tehran, 2013-14

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## Abstract

**Background:** Craniofacial injuries are a major cause of trauma-related disability and damage. Knowledge of the common causes of injuries to the head and facial areas and the resulting effects on the bone structures or brain tissue will be useful for healthcare personnel.

**Objectives:** The aim was to investigate the common causes of injuries in patients with craniofacial trauma, and to describe the resulting bone and soft tissue injuries.

**Methods:** In this one-year cross-sectional study (2013 - 14) which was carried out in a tertiary referral hospital, 416 patients who suffered from various forms of craniofacial traumatic injuries (resulting from traffic accidents, assaults, falls, etc.) were enrolled in the study on a consecutive basis. Their medical records and radiographs were examined, and interviews were conducted with the patients and their family members to determine the exact causes of the injuries.

**Results:** Of the 416 cases, 356 were males (85.6%). Mean (SD) age was 33.1 (21.1) years. The most common cause of injury was falls (137 cases, 32.9%) followed by motorcycle accidents (86 cases, 20.7%). Of the 206 patients with skull fractures (49.5% of the sample), 125 (58.4% of the group) were in non-motor vehicle accidents versus 81 patients (40.1%) who were in the motor vehicle accident group ( $P < 0.0001$ ). Facial bone fractures were more common among those with non-motor vehicle accident injuries (28.5%) versus those who had been in motor vehicle accidents (12.4%,  $P < 0.0001$ ). Conversely, intracranial hemorrhage (74.3% vs. 58.9%,  $P = 0.001$ ) and brain tissue injuries including a contusion, edema, herniation, or burst lobe (44.6% vs. 24.8%,  $P < 0.0001$ ) were respectively more prevalent in motor vehicle accident traumas than in non-vehicle motor accident injuries. At follow-up, 34 patients had died during hospitalization, 69 patients had undergone cranial surgery, and 67 required facial surgery.

**Conclusions:** Craniofacial injuries were more common in males in their thirties, with falls and motorcycle accidents as the most common causes. In motor vehicle accidents, we observed a significantly higher proportion of intracranial hemorrhages and brain tissue injuries. In non-motor vehicle accidents (including falls, assaults, accidentally hitting the head/face with a sharp/hard object, etc.), skull/facial bone fractures were more common. These findings can be considered by clinicians as well as forensic medicine specialists.

**Keywords:** Wounds and Injuries, Causes, Craniofacial, Iran

## 1. Background

Trauma is a major cause of morbidity and mortality worldwide. In Iran, similar to other developing countries, trauma is considered as the main cause of morbidity, especially for younger age groups (1). Among various anatomical locations considered to be clinically significant for traumatic injuries, those which involve the craniofacial area have been mentioned as the most common causes of trauma-related disability or death (2). The skull and face are usually involved in various traumatic events, including violence, motor vehicle accidents, gunshot wounds, sporting activities, and falls (2-5). It is estimated that in 75% of traumatic injuries, the head and face are involved (6). The

head is an area which is highly likely to be involved in any kind of trauma, whether it be penetrating or blunt. However, this part of the body, compared to other anatomical parts, is more susceptible to be involved in blunt trauma (7). Craniofacial injuries have gained increased attention from experts in this field given that the occurrence of undiagnosed concomitant injuries in other critical areas nearby (e.g., cervical spine injuries) is the leading cause of mortality. As a result, some international standards and guidelines, such as those put forth by the American College of Surgeons Advanced Trauma Life Support (ATLS), have been questioned by some experts regarding some of their limitations in assessing patients with craniofacial injuries (5, 8, 9).

Due to the involvement of various important anatomical structures and their complexity, such as the facial bones and cranial nerves, a thorough physical examination with a determination of the patient's complete medical history is required to avoid missing any injuries. Advanced imaging techniques, such as CT scanning, also help in the management of traumatic craniofacial injuries. However, in spite of these efforts, the literature suggests that some injuries are still missed unexpectedly (6, 10), especially temporal bone fractures and intracranial hemorrhages.

Knowledge of the epidemiology of craniofacial injuries enables clinicians and forensic medicine specialists to predict the type and extension of the injury encountered in emergency services or forensic medicine centers. It helps experts when dealing with the patients at the scene to predict the type of the injury that the patients most likely may have suffered (4). It also helps them to find any concomitant injuries which are likely to be missed inadvertently. For example, mid-facial injuries have been found to be significantly correlated with brain trauma (11) and other injuries.

As craniofacial injuries are among the most common injuries encountered in forensic centers and emergency rooms, having good knowledge of the more common causes of trauma and the resulting injuries is essential. Unfortunately, however, there is not enough literature about this topic from Iran (1).

## 2. Objectives

As there is evidence that the epidemiology of craniofacial injuries varies in different communities (12, 13), and given that more reports are required in this field, we decided to conduct this study in order to explore the most common causes of traumatic injuries in Iran and the resulting bone and soft tissue injuries to compensate for this absence in the available literature. We believe that the findings of this study will be helpful for not only forensic medicine experts, but also for emergency doctors and surgeons.

## 3. Methods

This cross-sectional study was conducted from September 2013 to September 2014 in a major university hospital in Tehran, Iran. The target subjects, who were consecutively enrolled in the study, were comprised of patients with traumatic craniofacial injuries admitted to the emergency services room of the hospital. The inclusion criteria consisted of patients who were admitted to the hospital due to craniofacial injuries of any cause, including penetrating and

blunt injuries such as those incurred from a motor vehicle accidents, motorcycle accidents, falls, or assaults. Exclusion criteria consisted of patients with equivocal histories, children who were not able to describe the causes of injury, non-traumatic intracranial hemorrhages, and patients for whom the causes of injury were not obvious (either because of a defective history or incomplete medical record). The sample size required for this study was estimated for traumatic brain injury data (14) using the formula  $N = Z^2_{(1-\alpha/2)} pq/d^2$ , with  $P = 0.558$ ,  $d = 0.05$ , and  $\alpha = 0.05$ . The minimum required sample size was calculated as 392 subjects. The sampling method was based on non-probability sampling (convenience type), and in the study time period (12 months), a total of 416 patients were included in the study.

A checklist was designed to document the required data. The information gathered included demographic data (age and gender), the cause of injury, reports from physical examinations, and radiologic studies (regular X-ray, CT scan, or MRI). The data gathering was performed by a forensic medicine resident through meticulous review of medical records and radiologic reports to determine the exact cause of injury. In addition to the data extracted from the medical records, the resident interviewed the patients or their parents (in the case of children), examined the patients, and completed the checklists. The variables collected included the cause of the injury (motor vehicle accident, fall, assault, or a separate group termed "others," which included injuries resulting from factors not categorized in the aforementioned groups, such as a sporting activity, suicide attempt, accidentally hitting the head/face with a sharp/hard object, accidental dropping of hard objects from some height onto the head/face area, or explosion), Glasgow Coma Scale (GCS) scores of the patients (13-15 = mild, 9-12 = moderate, and < 8 = severe), nature of skull and facial fractures (e.g., a mixed fracture was defined as simultaneous fracture of two or more bone structures in the craniofacial area), and other important clinical signs, such as otorrhea, rhinorrhea, bilateral periorbital ecchymosis (raccoon eye), and Battle's sign.

After collecting the data, they were then entered into SPSS software for Windows (ver. 20.0) for analysis. Descriptive indices including mean ( $\pm$ SD) were used to express the quantitative data and frequency (percentage) for the categorical data. In order to compare the proportion of patients with the desired outcome between the groups of trauma causes, a chi-squared test was used with alpha considered as 5%. For the purpose of making comparisons, the patients were divided into two groups: those in motor vehicle accidents vs. those with injuries from other causes. This decision was made based on the assessment that motor vehicle accidents comprised a significant proportion of

the patients documented in this study.

The ethics committee of our university approved the study protocol (Letter No. 1424, dated 2 June 2013). All information was kept confidential and only used for scientific purposes.

#### 4. Results

In total, 416 patients were included in the study. There were 356 males (85.6%) and 60 females (14.4%). The mean ( $\pm$ SD) age of the patients was 33.14 ( $\pm$ 21.18) years (range: two months old to 88 years old). The mean ( $\pm$ SD) hospitalization period was 7.1 ( $\pm$ 33.1) days (range: one to 127 days).

The most common causes of injuries were (in order): falls (137 patients, 32.9%), motorcycle accidents (86 cases, 20.7%), motor vehicle accidents involving pedestrians (79 cases, 19%), motor vehicle accidents involving people in automobiles (37 cases, 8.9%), assaults (17 cases, 4.1%), and others (60 cases, 14.4%). About 98.8% of the injuries were of the blunt type, and 1.2% were penetrating trauma injuries. Regarding the GCS scores of the patients, 319 patients (76.7%) had mild head injuries, 50 cases (12%) had moderate injuries, and 47 cases (11.3%) had severe injuries.

There were 206 cases of skull fractures (49.5%). The most common skull fracture type was a mixed fracture (i.e., more than two bones involved) observed in 29.5% of cases, followed by frontal bone (12.3%), temporal bone (11.8%), skull base (10.8%), parietal bone (9.9%), and occipital bone (3.6%) fractures. Table 1 shows the frequency distribution of skull and facial bone fractures among various causes of injuries. The patients who did not have skull fractures were more common than those who had fractures among motor vehicle accident patients (12.4% vs. 4.9%) and motorcycle accident patients (23.4% vs. 17.6%). Most fractures were of the linear type (88.9%), followed by depressed fractures (4.8%), compound with depressed fractures (2.9%), compound fractures (1.9%), and spider fractures (0.5%). Bone fractures were more common in non-motor vehicle accident traumas vs. motor vehicle accident injuries (58.4% vs. 40.1% for skull fracture and 28.5% vs. 12.4% for facial bone fractures, respectively, with  $P < 0.001$ ). A higher proportion of patients in non-motor vehicle accidents had skull fractures (125 cases out of 212, 58.4%) in comparison to patients in the motor vehicle accident group (81 patients out of 202, 40.1%;  $P < 0.0001$ ; See Table 1).

Eighty-six patients had facial bone fractures (20.8%). The most common types of bones involved were, in order, nasal (27.2%), orbital wall (1.9%), maxillary (1%), and mandibular (1%). The number of patients without fractures was more common than those with fractures among motor vehicle accident patients (9.5% vs. 7%), motorcyclists (21.3% vs. 17.4%), pedestrians (22.9% vs. 4.7%), and those

**Table 1.** Frequency of Skull and Facial Bone Fractures According to the Mechanism of Injury<sup>a</sup>

	Skull Fracture	Facial Bone Fracture
Motor vehicle accidents, N = 202	81 (40.1%)	25 (12.4%)
Non-motor vehicle accidents, N = 214	125 (58.4%)	61 (28.5%)
<b>Total, N = 416</b>	<b>206 (49.5%)</b>	<b>86 (20.8%)</b>

<sup>a</sup>Percentages are shown according to the mechanism of injury (row percentage).

with falls (33.5% vs. 30.2%). Among patients who fell from heights, the most common locations of the fractures were the occipital bone (50%) and the maxillary/mandibular or orbital bone (50%). Compared to skull fractures, facial bone fractures were more common in non-vehicle motor accidents (61 patients, 28.5%) than in motor vehicle accidents (25 patients, 12.4%;  $P < 0.0001$ ; See Table 1).

The frequencies of various brain tissue injuries were as follows: intracranial hemorrhage (273 cases, 65.6%), cerebral contusion (113 cases, 27.1%), concussion (276 cases, 66.3%), and burst lobe (35 cases, 8.4%). The most common type of intracranial bleeding was epidural hemorrhage (80 patients, 29%) followed by mixed hemorrhage or bleeding in more than one location (68 cases, 24.6%), subdural hemorrhage (56 cases, 20.3%), subarachnoid hemorrhage (55 cases, 19.9%), intraparenchymal hemorrhage (13 cases, 13%), and intraventricular hemorrhage (four cases, 1.4%). Table 2 presents the frequency distribution of various types of intracranial bleeding according to the cause of injury. In contrast to skull and facial bone fractures, intracranial hemorrhage (of any type) was more prevalent in people injured in motor vehicle accidents (150 cases, 74.3%) compared to non-motor vehicle accident patients (126 cases, 58.9%;  $P = 0.001$ ; See Figure 1). Table 3 presents the frequency of brain tissue injuries in different injury categories. In total, 143 patients (34.4%) had radiologic evidence of brain tissue injury. This figure was significantly more common in those injured in motor vehicle accidents (90 cases, 44.6%) versus those patients in the non-motor vehicle accident group (53 cases, 24.8%;  $P < 0.0001$ ).

At follow-up, 34 patients had died during hospitalization, 69 patients required cranial surgery, and 67 patients required facial surgery.

#### 5. Discussion

The objective of this study was to describe the most common causes of injuries and the resulting bone and soft tissue injuries among patients who were admitted to

**Table 2.** Frequency Distribution of Various Types of Intracranial Hemorrhage (Total of 276 Patients With This Condition) Based on Injury Cause<sup>a</sup>

	EPD	SDH	SAH	IPH	IVH	Mixed <sup>b</sup>
<b>Motor vehicle accidents, N = 202</b>	33 (22%)	30 (20%)	36 (24%)	5 (3.3%)	3 (2%)	43 (28.7%)
<b>Non-motor vehicle accidents, N = 214</b>	47 (37.3%)	26 (20.6%)	19 (15.1%)	8 (6.3%)	1 (0.8%)	25 (19.8%)
<b>Total, N = 416</b>	80 (19.2%)	56 (13.4%)	55 (13.2%)	13 (3.1%)	4 (1%)	68 (16.3%)

Abbreviation: EPD, epidural hemorrhage; SAH, subarachnoid hemorrhage; SDH, subdural hemorrhage; IPH, intraparenchymal hemorrhage; IVH, intraventricular hemorrhage.

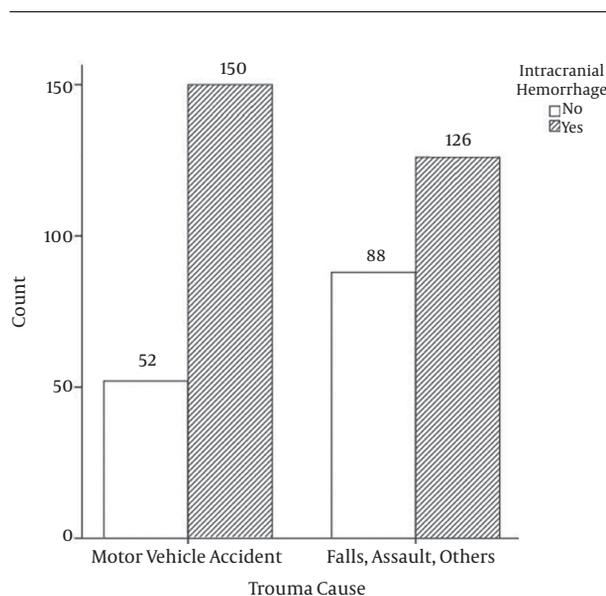
<sup>a</sup> Percentages are shown according to the mechanism of injury (row percentage).

<sup>b</sup> 2 types of hemorrhage.

**Table 3.** Frequency Distribution of Various Brain Tissue Injuries (a Total of 163 Lesions in 143 Patients) According to the Mechanism of Injury<sup>a</sup>

	Contusion	Brain edema	Herniation	Burst lobe
<b>Motor vehicle accidents, N= 202</b>	71 (35.1%)	8 (4%)	1 (0.5%)	23 (11.4%)
<b>Non-motor vehicle accidents, N=214</b>	42 (19.6%)	6 (2.8%)	0	12 (5.6%)
<b>Total, N=416</b>	113 (27.1%)	14 (3.4%)	1 (0.2%)	35 (8.4%)

<sup>a</sup> Percentages are shown according to the mechanism of injury (row percentage).

**Figure 1.** Cluster Bar Showing the Frequency of Patients with Intracranial Hemorrhage According to the Cause of Injury

a trauma hospital in Tehran with craniofacial injuries. As stated previously, craniofacial injuries are regarded as the most common and important causes of mortality and morbidity in trauma patients. Surprisingly, however, studies about these types of injuries in Iran are not sufficient. In a previous report using forensic center documents, CNS injuries and skull base fractures were noted as the most common causes of death among Iranian patients injured

in road traffic accidents (2). The results we observed here had some similarities and differences with the previous reports (15-17). Knowledge of the common types of injuries in each trauma category yield invaluable information. For example, by knowing that falls or motor vehicle accidents are commonly associated with skull fractures, doctors could be more alert to searching for these fractures and avoid missing those associated with other complications if not diagnosed in a timely fashion (18).

In a previous study to determine the particular details of 305 patients who had sustained falls, the authors reported that head injuries were the most common injury type seen in 62.2% of the patients, which necessitated craniotomies in 2.3% of the cases. The authors concluded that the high number of head injuries reported should alert doctors about possible occult injuries among patients who fall (19). In a previous Iranian population-based study on traumatic brain injury conducted in West Azerbaijan province in 2006 (20), the most common age group was 20 - 29 years, and the most prevalent mechanism of injury was motor vehicle accidents. In another study in Egypt (3), the pattern of craniofacial injuries among 255 patients was described. Although we spotted falls as the most common injury type here, the aforementioned article (3) reported that traffic accidents were the most common cause of craniofacial injuries. Similar to our results, in Hassan et al.'s study (3), males were more affected by craniofacial injuries. They reported that about 7% had concussions and 4.71% had cerebral contusions.

Another important finding involves the difference in

mean ages of the samples. Our sample had a higher mean age (33 years) than the Egyptian study, in which the mean age of the patients was younger at 19 years. The authors of the Egyptian study concluded that the likelihood of skull fractures increased in traffic accidents (3).

In a Canadian study (18), the epidemiology of craniofacial injuries was assessed in 2,969 trauma patients with severe injuries in 12 trauma hospitals. In our study, we included patients with any injury severity and found that falls were the most common injury type. However, in the Canadian study, traffic injuries were reported as the most common cause of severe craniofacial injuries, and most of these patients had decreased levels of consciousness and injuries to the skull and brain tissue.

In another study in the US (21) on 151 patients with facial fractures, assault was reported as the most prevalent cause of injury in about 40% of patients, followed by traffic accidents. In contrast to our study, in which we found the nasal region as the most commonly involved bones in the face, they reported the orbital wall as the most common. This could be due to difference in the mechanisms of the injuries between the two studies. A Nigerian study also reported that the middle third of the face was the most common anatomical location affected in motorcycle-related traumatic injuries (22).

Although many studies report concomitant effects due to craniofacial injuries, isolated injuries are also considerable. In a previous review to determine the pattern of craniofacial injuries in the United Arab Emirates (23), it was reported that about half of the patients had isolated fractures of the mandible, and about a third had fractures of the mid-facial area. The most common age group involved was the 16 to 20-year-old group, which is younger than what we reported here.

In this study, we divided the injury causes into several groups. In other words, motor vehicle accidents and motorcycle injuries were categorized into two different groups. The categorization used in some of the other literature is different. In another study from Malaysia (24), for example, motorcycle injuries were recognized as the most common cause of facial injuries. Most studies put these two mechanisms of injuries into one category under traffic accidents. In the mentioned study in the UAE, road traffic accidents were the most common injury mechanism, followed by falls. In contrast, in a Brazilian study, after traffic accidents, physical assaults were named as a common cause of craniofacial injury (25).

One of the clinical difficulties in patients with craniofacial injuries is the complex nature of the traumas. In other words, many patients have several simultaneous soft tissue injuries or bone structure fractures. A method to handle this is to define a dominant injury. However, the

definition of the dominant injury is not always so simple. In a previous study (26), it was found that patients with traumatic head trauma with more than one injury had the same prognosis as those with a single injury.

We faced some limitations in this study. First, we did not have access to the records of patients who died at the scene, as no medical records were available for these cases. As the sample consisted of hospital medical records, adding these cases from records of forensic centers will provide more information about more serious injuries. Also, the histories of accidents and other injuries were provided by victims, witnesses, or paramedic personnel at the scene both in medical records and during interviews for further data gathering, which may be unreliable in some cases. Another related limitation concerns the issue that some patients had some concomitant injuries in other parts of the body. Although we tried to elucidate the exact causes of the injuries and what had happened at the trauma scenes, it is likely that some patients or their accompanied persons were not able to remember the trauma details completely or accurately.

In conclusion, males in their thirties and those subject to falls or motorcycle accidents were the most common types of patients. We observed a higher proportion of intracranial hemorrhages and brain tissue injuries in patients of motor vehicle accidents. On the other hand, in those patients from non-motor vehicle accidents (falls, assaults, accidentally hitting the head/face with a sharp/hard object, etc.), skull/facial bone fractures were more common.

### 5.1. Suggestions for Future Studies

In addition to one hospital, it may be helpful to enroll more medical centers from major cities and smaller cities, as well as both rural and urban areas, for better understanding of the causes and extents of craniofacial injuries in Iran. Also, longer follow-up of the patients would be useful to find any correlation between trauma mechanisms and the prognoses of the patients. For example, it could be determined how patients with certain brain injuries who survived will be able to cope with daily activities after being discharged from the hospital.

### Footnote

**Authors' Contribution:** Study concept and design: Sepehrdad Khalatbari, Kamran Aghakhani; acquisition of data: Sepehrdad Khalatbari, Faranak Hayati, Fouroozan Fares; drafting of the manuscript: Azra Soltanmohammadi, Morteza Keyvan; critical revision of the manuscript for important intellectual content: Fattah Taftachi; statistical

analysis: Sepehrdad Khalatbari; administrative, technical, and material support: Sepehrdad Khalatbari, Alireza Behzadi; study supervision: Sepehrdad Khalatbari, Kamran Aghakhani.

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