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## Maxillofacial fracture epidemiology and treatment plans in the Northeast of Iran: A retrospective study

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### Abstract

**Background:** The epidemiology of facial injuries varies based on lifestyle, cultural background and socioeconomic status in different countries and geographic zones. This study evaluated the epidemiology of maxillofacial fractures and treatment plans in hospitalized patients in Northeast of Iran (2015-2016).

**Material and Methods:** In this retrospective study, the medical records of 502 hospitalized patients were evaluated in the Department of Maxillofacial Surgery in Kamyab Hospital in Mashhad, Iran. The type and cause of fractures and treatment plans were recorded in a checklist. Data were analyzed with Mann-Whitney test, chi-squared test and Fisher's exact test, using SPSS 21.

**Results:** The majority of patients were male (80.3%). Most subjects were in 20-30-year age range (43.2%). The fractures were mostly caused by accidents, particularly motorcycle accidents (MCAs), and the most common site of involvement was the body of the mandible. There was a significant association between the type of treatment and age. In fact, the age range of 16-59 years underwent open reduction internal fixation (ORIF) more than other age ranges ( $P=0.001$ ). Also, there was a significant association between gender and fractures ( $P=0.002$ ).

**Conclusions:** It was concluded that patient age and gender and trauma significantly affected the prevalence of maxillofacial traumas, fracture types and treatment plans. This information would be useful for making better health policy strategies.

**Key words:** Epidemiology, treatment, facial injuries, maxillofacial fractures, trauma.

## Introduction

An increase in population in cities and industrial development has resulted in changes in lifestyles and personal activities. These changes result in increasing rate of injuries, especially maxillofacial fractures (Fx) owing to the specific anatomical features of this region (1,2). These injuries are one of the most common issues dealt with by both maxillofacial and plastic surgeons in their professional practice (3).

These fractures might give rise to socioeconomic burden and deleterious effects on both the community and health system. These injuries are among the major health concerns worldwide (4,5). Furthermore, treatment and rehabilitation of maxillofacial fractures are associated with psychological and esthetic concerns, severe morbidity and disabilities. In addition, these traumas would impose a significant financial burden on individuals and societies (6,7). Therefore it is necessary to pay more attention to their epidemiology and details.

In most parts of the world, major causes of facial fractures are motor vehicle accidents (MVA), falls, assaults, sports and occupational injuries (5,8). Epidemiology and pattern of soft and hard facial tissue injuries vary in different societies as a function of cultural and socioeconomic factors (9).

Several studies have investigated the epidemiology of maxillofacial fractures in different countries and populations (10-15). However, there is still limited data regarding the epidemiology and treatment plans of facial injuries in developing countries, especially in Iran.

Some researchers have investigated the prevalence of maxillofacial fractures in different provinces and regions of Iran (16-18); for example, the senior author has already studied the maxillofacial fracture epidemiology in the southeast of Iran (5). However, there is still a lack of sufficient information about the etiology, prevalence, epidemiology and outcomes of these injuries, especially in the northeast of Iran as a result of its specific socio-political and religious conditions.

According to the literature, MVAs are the most common cause of maxillofacial fractures in Iran, like other developing countries (5,19-22). However, assaults are the dominant casual factors for MVAs in developed countries (5,23). This difference is attributed to differences in safety driving rules (24).

Mashhad as the Capital of Khorasan Province receives the maximum number of passengers and pilgrims annually and due to its short distance from Afghanistan, a lot of road accidents, assaults and gunshots take place there (25). These victims are mainly transferred or referred to Trauma Emergency Center of Shahid Kamyab Hospital since this hospital is a major educational and therapeutic multiple trauma center in Khorasan.

Epidemiologic investigations and study of the factors in the region are very important. The present study in

the second one which is done in Iran and according to numerous accidents in developing countries, especially Iran, pay attention to the factor of fractures by accidents is very essential. Therefore, the present study was undertaken to develop and analyze the available epidemiological and statistical data related to facial fractures in Iran and also to evaluate the incidence of maxillofacial fractures in hospitalized patients in terms of age, gender, types and causes of trauma and treatment plans in the Oral and Maxillofacial Surgery Department of Shahid Kamyab Hospital in Mashhad, located in the north-east of Iran during 2015-2016 by considering clinical, demographic and radiographic data.

## Material and Methods

The study was designed as a retrospective cross-sectional study with the ethical code IR.mums.sd.REC.1394.127. The study was approved by the Institutional Human Research and Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran.

This was a census-based study to assess the prevalence, types and causes of trauma in patients with maxillofacial fractures. Therefore, all the patients with a diagnosis of maxillofacial fracture, who were admitted and treated in Shahid Kamyab Hospital, Mashhad, Iran in 2015-2016, were included in the study. The sample size was calculated at 561 cases according to the admission office information. Ethical considerations were taken into account throughout the study, and the patients' names and medical information remained completely confidential.

The exclusion criteria were as follows: 1) incomplete medical records; 2) patients with only dentoalveolar fractures undergoing reduction by arch bar without hospitalization; 3) patients with only soft tissue injuries, who were treated in the emergency room without hospitalization; 4) patients undergoing other procedures such as opening the arch bar, or removal of a plate in patients who underwent maxillofacial surgeries before. After excluding these cases, only 502 patients remained to be analyzed. All the demographic data (e.g. patients' age and gender) were collected, and the patients' medical records were examined to extract information related to the date of referral, cause of trauma, the affected bones, concomitant fractures and injuries of other organs, the exact maxillo-mandibular status, facial examinations, and radiographic images. Data collection tools included observation and census sampling of medical records and documents and also PACS (picture archiving and communicating system) and archived radiology reports data in the surgery ward of the hospital. The patients' methods of treatment were evaluated and surveyed in this study. Maxillofacial fractures were treated using the following methods in our department: 1) closed reduction (CR); 2) open surgical treatment or open reduction and internal fixation (ORIF); 3) combination thera-

py (both CR and ORIF), 4) follow-up and re-evaluation of the status of suspected fractures (without any specific treatments).

Then this data was imported to SPSS 21. We used descriptive statistics such as distribution and continuity (means and standard deviations) for representing the data collected.

For statistical analysis the significance level was set at 0.05; Mann–Whitney test was performed to compare differences in consequences among females and males and chi-squared test and Fisher’s exact test were used to analyze the relations between qualitative parameters.

**Results**

A total of 502 patients were evaluated in this study; 403 subjects (80.3%) were male and 99 (19.7%) were female. The mean age of the subjects was 28.8±13.56 years (age range: 2-80 years). The majority of cases were within the age range of 20-30 (43.2%) years, followed by 30-40 (16.7%) years and 10-20 (16.1%), respectively (Table 1). The highest rate of fractures occurred in summer

**Table 1:** Frequency of maxillofacial fractures in different age ranges.

Age groups (years)	N	%
0-9.9	27	5.4
10-19.9	81	16.1
20-29.9	217	43.2
30-39.9	84	16.7
40-49.9	51	10.2
50-59.9	24	4.8
60-69.9	10	2.0
70-79.9	7	1.4
80-89.9	1	0.2
Total	502	100.0

(29.1%). In fact, the highest rates were reported in September (11.9%) and October (10.2%), followed by April (10.0%). In total, 278 and 224 cases underwent treatment in 2015 and 2016, respectively. MCAs (motor cycle accidents) accounted for the majority of traumas (62.7%) and CAs (car accidents) (17.9%) ranked the second. A total of 832 anatomic and bone fractures were found in 502 patients, and in total, 1049 cases of fracture lines were reported.

In relation to categorization of fractures, 173 cases (34.5%) had simple fractures and 329 subjects (65.5%) had multiple fractures, while 39.4 % of cases had two lines of fracture.

As a matter of fact, the total percentage of fractures in anatomic locations was higher than 100%, given the possibility of having fractures in several locations.

The authors also determined the anatomical location of maxillofacial fractures. Among 502 patients evaluated, mandibular fractures had the highest frequency (58.8%), followed by zygomatico-maxillary complex (ZMC) fractures (36.7%) and the nasal bone (18.33%) (Table 2).

It should be noted that among 502 cases with 832 anatomic bone fractures, there were 295 patients with 426

**Table 2:** Frequency and percentage of the anatomical location of maxillofacial fractures in 502 patients.

Anatomic location	N (%)
Mandible	295 (58.8)
ZMC	184 (36.7)
Nasal Bone	92 (18.33)
Maxilla	76 (15.4)
Zygomatic arch	73 (14.5)
Orbit	67 (13.3)
NOE	9 (1.8)
Sum of patients	502(100)

ZMC = Zygomatico-Maxillary Complex, NOE= Naso-Orbito-Etmoidal.

different mandibular fractures. The most common anatomical location of fracture in the mandible was the body (39.67%), followed by parasymphysis (20.19%) and subcondylar fractures (16.67%), respectively. The lowest number of fractures was recorded in the coronoid area (1.17%) (Table 3).

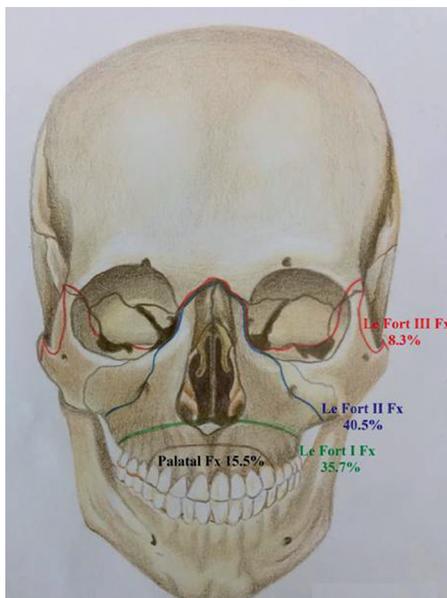
Based on Peterson’s classification (20), if parasymphysis is considered as a portion of symphysis, fracture frequency would be estimated at 22.7%. If the head and neck of condyle and subcondylar region are considered as a single component, the overall incidence of condylar fractures would be 25.12%.

A total of 84 fracture lines were observed in 76 patients with maxillary fractures. The most commonly reported site in patients with fractured maxilla was LeFort II (the maxilla separates from the face) with a prevalence of 40.48%, followed by LeFort I (the palate is separated from the maxilla) and LeFort III (craniofacial disjunction is present), with frequencies of 35.71% and 8.33%, respectively (Fig. 1).

Simultaneous injuries were reported in 158 patients (31.47%). The most common concomitant injuries were orthopedic fractures, reported in 71.5% of the patients, followed by cranial fractures with 29.47%.

**Table 3:** The frequency of the anatomical locations of mandibular fractures.

Site of mandibular fracture	N	%
Symphysis	8	1.88
Parasymphysis	86	20.19
Body	169	39.67
Angle	44	10.33
Vertical Ramus	7	1.64
Condylar Head	7	1.64
Condylar Neck	29	6.80
Subcondylar	71	16.67
Coronoid	5	1.17
Total	426	100



**Fig. 1:** The frequency and classification of maxillary fractures.

Furthermore, in these cases, the most frequent treatment was ORIF (43%), followed by a combination of CR and ORIF (33%) and CR (24%), respectively. It was possible to perform both CR and ORIF for several fractures in one patient simultaneously; in other word, the treatment plans would be 57.5% ORIF and 42.5% CR of all the treatments.

Table 4 shows the frequencies of maxillofacial treatment plans in terms of fracture sites (Table 4). According to the results, the ORIF treatments were performed more commonly for ZMC (29%) and mandibular body fractures (20.8%). However, the closed approach was a more prevalent treatment plan for nasal bone (24.1%) and subcondylar fractures (19.5%) ( $P=0.001$ ).

**Table 4:** Frequency and percentage of maxillofacial treatment plans regarding to fractures sites.

Site	C/R	ORIF
Subcondylar	64(19.5%)	7(1.1%)
ZMC	8(2.4%)	176(29%)
Zygomatic arch	46(14%)	27(4.4%)
NOE	5(1.5%)	4(0.6%)
Ramus	4(1.2%)	3(0.4%)
Orbital	8(2.4%)	59(9.7%)
Body	43(13.1%)	126(20.7%)
Condylar (head and neck)	27(8.2%)	9(1.4%)
Symphysis	0(0%)	8(1.3%)
Parasymphysis	22(6.7%)	64(10.5%)
Coronoid	4(1.2%)	1(0.2%)
Angle	6(1.9%)	38(6.3%)
Nasal	79(24%)	13(2.2%)
Palatal	3(0.9%)	9(1.5%)
Le Fort I	5(1.5%)	25(4%)
Le Fort II	4(1.2%)	30(5%)
Le Fort III	0(0%)	7(1.2%)
Sum	328(100%)	606(100%)

C/R: Closed Reduction, ORIF: Open Reduction & Internal Fixation.

Table 5 shows the association between maxillofacial fractures and gender and type of fracture (Table 5). The prevalence of fractures in males was 4.07 times higher than females. There was no significant age difference between male ( $28.98 \pm 15.65$ ) and female patients ( $28.10 \pm 13.01$ ) according to Mann-Whitney test ( $P=0.423$ ,  $Z=0.80$ ).

A significant association was observed between gender and the cause of fractures ( $P=0.001$ ). Males were more prone to MVAs and assaults, compared to females. In cases of assaults and falls, the fracture types were simple and isolated, while in car accidents and especially motorcycle accidents, most fractures were multiple. In this regard, chi-squared test showed a significant association between the type of fractures and cause of trauma ( $P=0.001$ ) (Table 5).

The findings showed that most maxillofacial treatment plan were open reduction (57.5%), followed by closed reduction (42.5%) in our department. In addition, in the age category of <15 years, most maxillofacial treatment plans were CR (58%); CR was also reported in the age category of >60 years (81%). However, in the age range of 16-59 years, ORIF was the predominant treatment method (60.5%). Chi-squared test showed a significant difference between the type of treatment and age; in fact, the age range of 16-59 years underwent open treatment more than other age ranges ( $P=0.002$ ) (Table 6).

**Table 5:** Association between the cause of maxillofacial fractures, gender, and type of fracture.

Variables			Cause of Trauma						*P Value
			CA	MCA	Assault	Falling Down	Etc.	Total	
Type of Fracture	Simple	N	36	78	25	33	1	173	**P=0.001
		%	40	24.8	69.4	58.9	20	34.5	
	Multiple	N	54	237	11	23	4	329	
		%	60	75.2	30.6	41.1	80	65.5	
	Total	N	90	315	36	56	5	502	
		%	100	100	100	100	100	100	
Gender	Female	N	10	56	13	19	1	99	**P=0.001
		%	10.1	56.6	13.1	19.2	1.0	100	
	Male	N	80	259	23	37	4	403	
		%	19.9	64.3	5.7	9.2	1.0	100	
	Total	N	90	315	36	56	5	502	
		%	17.9	62.7	7.2	11.2	1.0	100	

\*Chi-square test, \*\* P<0.05 is significant, CA: Car Accident, MCA: Motor Cycle Accident.

**Table 6:** Frequency of treatment plans according to patients' age categories.

Variables			Treatment Plan		Treatment Plans (N)	Patients (N)
			ORIF	C/R		
Age Groups (Y)	≤15	N	26	36	62	59
		%	41.9	58.1	100	100
	16-59	N	354	231	585	425
		%	60.5	39.5	100	100
	≥60	N	4	17	21	18
		%	19	81	100	100
Sum of treatment plans		N	384	284	668	502
		%	57.4	42.5	100	100

C/R: Closed Reduction, ORIF: Open Reduction & Internal Fixation.

**Discussion**

In addition to the possible life-threatening nature of facial traumas, these injuries might cause esthetic or functional deformities which might lead to psychological, financial and social costs for people and society (5). Therefore, it is of high significance to identify the etiology and epidemiology and treatment plans of maxillofacial traumas.

Mashhad, the capital of Khorasan Razavi Province, is the second largest and most developed city in Iran with a population of approximately 6 million in the last cen-

sus (2011) (26,27). This city is important because of its religious nature and hosts a large number of passengers and Muslim pilgrims from other cities and also neighboring countries each year (25).

The Oral and Maxillofacial Surgery Department of Kamyab Hospital of Mashhad is the most equipped and highly advanced maxillofacial surgery department in the northeast of Iran.

Most of the epidemiological studies on maxillofacial fractures have been performed retrospectively (3-6,11,16,19,20,28-35).

During 2 years, from January 2015 to December 2016, 502 patients were treated by the oral and maxillofacial surgery staff and residents in our department. In our study, the patient-to-year ratio was higher than what has been reported in most investigations into the prevalence of maxillofacial fractures in Iran (5,16,18-20,22,28,36), Italy (37), India (32,33,38), Brazil (4,39,40), Netherlands (41) and Serbia (42).

The analysis of this sample might provide useful knowledge about the current distribution of facial fractures in the northeast of Iran, as well as offering a new valuable health care system database that might improve medical and dental policies to prevent and manage facial trauma.

As we reported, the incidence rate of fractures in men was higher than that in women (4.07/1). This finding was consistent with several previously conducted studies by Lee, Cabalag, Balli and Paes *et al.* (4,38,43,44), as males are generally more socially active and more involved in life-threatening activities, careless fast car and motorcycle driving, sports and violence.

The highest number of injuries was reported in the age range of 20-30 years, consistent with other studies (4,5, 10,12,16,18,21,23,35,38,42,45-50).

Considering the careless and fast driving attitude without the use of safety belts or helmets in this age range and also the interest in adventures and assaults among the youth, they are more prone to traumas.

Based on the results, the highest number of traumas was noted in September, October and April, consistent with the findings by other studies (5,12,28,41,51-53).

This result can be explained by the fact that Iranian people tend to be more exposed to trauma risk factors in the summer and spring, because of engaging more frequently in physical activities, taking part in social Norouz reunions and summer holiday road trips. In addition, motorcycle accidents were common in the summer, which can be due to difficulty of helmet wearing in hot weather (54).

According to Huelke and Compton, although car accidents are more frequent, motorbike accidents are usually more severe (55).

Our study showed that MCAs were the most common cause of fractures (62.7%), followed by CA (17.9%). This would be explained by high-speed and careless driving in Mashhad, along with disrespect for traffic laws and the frequent disregard for wearing helmets.

This finding was consistent with the results of most Iranian studies (5,21,36) and some studies in other countries (10,30,31,50,51,55).

However, cultural differences, sports activities, daily tasks, occupational status and strict driving rules might affect the etiology of maxillofacial traumas, leading to discrepancies between various studies.

Our findings showed that the mandible was the most

involved bone (58.8%), consistent with other studies (5,10,12,17,31,32,39,50).

Some other researchers such as Mohajerani, Arangio, Van Hout and VanAs *et al.* found that facial fractures in the zygomatic complex were more frequent (21,37,41,56). ZMC fracture was the second most frequent fracture in our study.

Zandi, Momeni and Hussain *et al.* showed that nasal bone fractures were the most prevalent type of trauma (22,36,57), which were the third most prevalent maxillofacial fracture in the present study.

Minor differences in the frequency of fractures can be caused by variations in the etiology of fractures in various regions and the difference in patients' referral system.

As the MVAs with their high-energy impact were the most frequent cause of trauma in our research, multiple fractures were more prevalent (65.5%) than isolated ones. This finding is consistent with the results of a study by Samieirad *et al.* in Kerman (5).

Lee and Anbiaee *et al.* showed that mandibular body region accounted for the highest number of fractures (25,44), consistent with our results. However, Balli and Samieirad *et al.* reported parasymphysis as the most prevalent site (5,38), which ranked the second in our research.

Our findings are compatible with those of a study by Motamedi *et al.* as they reported that Lefort II fractures were most frequent in the maxilla (18).

Momeni and Samieirad *et al.* reported orthopedic injuries as the most common associated trauma (5,36), consistent with the current findings indicating that orthopedic injuries (71.5%) were the most prevalent concomitant injuries.

The most prevalent method of treatment in our department was open reduction and internal fixation (ORIF) (57.5%), consistent with other results (38,40,43,44).

No complications concerning occlusion and mouth opening and even sensory nerve paresthesia and infection were encountered in these patients.

Recently, plate osteosynthesis has become popular in the management of facial fractures and in the treatment of mandibular fractures all over the world, especially in Iran (5,38). Surgeons prefer ORIF because it offers the advantages of stable and precise anatomical reduction of fragments, allows immediate recovery of function as it has no IMF (inter-maxillary fixation). This treatment plan would decrease the period of bone healing and the recovery period (5).

The treatment plan selection is based on patients' age and also anatomic location of fractures. In our department, ORIF surgeries are performed routinely for ZMC and mandibular body fractures; however, most of the nasal and mandibular subcondylar fractures are treated with closed approach.

This treatment plan is consistent with scientific protocols for the management of facial fractures in order to achieve the best functional and esthetic outcomes with the least scars and sensory or motor nerve complications (58-62).

It is of interest that patients under 15 and over 60 years of age were treated mostly by closed reduction in this study. These findings were compatible with the results of studies by Samieirad, Zandi and Kambalimath *et al.* (5,22,33).

Because of high osteogenic potential in pediatric age, even ORIF might increase the risk of tooth bud injuries and also induce developmental asymmetry. Therefore, closed reduction can be a good therapeutic choice (33,63). Considering the low repairing capacity and systemic health problems in geriatric ages, ORIF treatment has its own complications (64,65). Therefore, patients in extreme age ranges would benefit from closed reduction treatment plans.

The following simplified message are made after analysis of the results of the present study:

- Accidents are a serious public health problem in Iran because of a variety of reasons including young population of the country which leads to more exposure to accident, low gas price, decreased ratio of transports by public transportation than with private vehicles, and non-standard safety designs (66).

- Accidents and its related injuries contribute to a significant proportion of the burden of diseases in Iran. They also have a significant impact on the social and economic well-being of people. Also, the worldwide road traffic injury/death rate is 3 people per 10 000 vehicles, but in Iran it is 33 people per 10 000 vehicles (67).

- Epidemiologic investigations and study of the factors in the region are very important. The present study in the second one which is done in Iran and according to numerous accidents in developing countries, especially Iran, pay attention to the factor of fractures by accidents is very essential.

- In the present study an attempt is made to investigate all of factors lead to fractures in accidents and same curing treatment is studied.

- Mashhad, the capital of Khorasan Razavi Province, is the second largest and most developed city in Iran with a population of approximately 6 million in the last census. This city is important because of its religious nature and hosts a large number of passengers and Muslim pilgrims from other cities and also neighboring countries each year.

## Conclusions

It can be concluded that patients' age, gender and also trauma causes would significantly affect the prevalence of maxillofacial traumas, fracture types and also the decision about the best treatment plan. This would be

beneficial for appropriate health care policy and management set-up in every developing society for education, prevention and treatment.

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*Conflict of Interests*

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