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ORIGINAL ARTICLE

Patterns of maxillofacial fractures in Hofuf, Saudi Arabia: A 10-year retrospective case series

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KEYWORDS

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Abstract *Objectives:* This retrospective study was performed to analyze the incidence, etiology, and types of maxillofacial fractures in a major city in Eastern Province, Saudi Arabia.

Materials and methods: The medical records of all patients treated in the operating rooms for maxillofacial fractures by the Oral and Maxillofacial Surgery Department at King Fahad Hospital, Hofuf, Al-Ahsa, Saudi Arabia, between January 1, 2007, and December 31, 2016, were reviewed. A total of 270 patients with complete records were included. The data extracted included the age, gender, nationality, causes of injury, and patterns of maxillofacial fractures involved.

Results: Among the 270 patients, 241 (89.3%) were males, and 29 (10.7%) were females. The young adult (19–44 years) age group was the most affected (65.6%). Road traffic accidents (63.3%) were found to be the most frequent causes of maxillofacial fractures; falls were the second most common (15.9%). The rate of mandibular (54.6%) fractures was higher than that of midfacial (45.4%) fractures. Among the mandibular fractures, the most common type was the parasymphyseal fracture (24.6%). Zygomatic fractures were the most common (48.6%) of midface fractures.

Conclusions: Similar to reports of other studies in different regions of Saudi Arabia, Al-Ahsa showed that road traffic accidents were the most predominant etiology of maxillofacial fractures affecting most frequently males of young adult age group. These findings emphasize the need for better education of road safety and enforcement of traffic laws, especially for the most affected age group.

1. Introduction

The face is liable to traumatic injuries owing to its high exposure as part of the body (Weihsin et al., 2014). Oral and maxillofacial injuries can be defined as injuries involving soft and hard tissue structures of the facial region and oral cavity, including the teeth and vital structures of the head and neck area as a result of trauma (Majambo et al., 2013). These

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injuries are a significant health problem worldwide (Lee et al., 2017). In addition, they inflict a public health burden regarding workload, time consumption, treatment cost, and psychological effects on the victims (Boffano et al., 2014).

The epidemiology of maxillofacial injuries varies between the populations in which these injuries are studied. This variation exists between every two countries, and in the different regions of the same country. Factors like geographic regions, culture, social and economic status, the population density, and the period of the year can influence both the type and the distribution of maxillofacial injuries (Abdullah et al., 2013; Al-Khateeb and Abdullah, 2007; Gandhi et al., 2011; Hogg et al., 2000).

The body of information available now on maxillofacial fractures in Saudi Arabia requires a further addition to obtain a clearer picture of the patterns of these fractures in the kingdom. Some published studies investigated maxillofacial trauma in Saudi Arabia in different regions such as Al-Medina (Rabi and Khateery, 2002), Riyadh (Abdullah et al., 2013; Nwoku and Oluyadi, 2004), Aseer (Almasri, 2013), Makkah (Almasri et al., 2015), and Jeddah (Jan et al., 2015a, 2015b).

To our knowledge, no published studies have investigated the patterns of maxillofacial fractures in Al-Ahsa, Eastern Region, Saudi Arabia. The main aim of the current study was to review and analyze the incidence, etiology, and types of maxillofacial fractures over a 10-year period, in patients who were admitted and treated at King Fahad Hospital.

2. Material and methods

2.1. Study design

To address the research purpose, a retrospective case series study was performed.

2.2. Ethical approvals

The study was approved by the research committee of King Fahad Hospital (Hofuf), and by the Institutional Review Board of Riyadh Elm University.

2.3. Data collection

The files of all patients who were admitted for maxillofacial fractures and treated by open or closed reduction in the operating rooms of King Fahad Hospital, Hofuf, Saudi Arabia, during the period from January 1, 2007, to December 31, 2016, were retrieved, reviewed, and analyzed. The conventional X-rays and computed tomography (CT) scans were examined to confirm the diagnosis.

2.4. Exclusion criteria

The following cases were excluded: isolated dentoalveolar fractures treated in an outpatient setting, isolated nasal bone fractures, isolated frontal bone fractures, follow-up procedures such as intermaxillary fixation release or removal of plates, isolated soft-tissue injuries, and patients with incomplete records.

2.5. Study variables and grouping

Data extracted from the medical records for each subject included the age, gender, nationality, causes of injury, and the types of maxillofacial fractures. Using the World Health Organization (WHO) classification (Gresele et al., 2013), the patients were divided into five age groups as follows: children ($\leq$12 years), adolescents (13–18 years), young adults (19–44 years), middle-aged (45–60 years), and elderly ($>$60 years). Causes of injury were classified into seven types: road traffic accident (RTA), fall, assaults, sports injury, industrial injury, gunshot, and animal attack.

The patterns of maxillofacial fractures were broadly classified as mandibular fractures and midfacial fractures. Mandibular fractures were more classified according to the anatomical location following the classification of Dingman and Natvig in 1969 (Cornelius et al., 2014) into symphyseal, parasymphyseal, body, angle, ramus, condylar, and coronoid fractures. Maxillary fractures were further classified, following the classification of Le Fort (1901) (Cunningham and Haug, 2004), into Le Fort I, II, and III. Zygomatic fractures were classified into: zygomatic complex fractures and isolated zygomatic arch fractures (Van Den Bergh et al., 2012).

2.6. Data analyses

Data were recorded on a special data collection sheet, entered into a Microsoft Excel Spreadsheet, then analysis was done using a Statistical Package for the Social Sciences (SPSS) software, version 22. All scale variables were analyzed for normality by using the Shapiro-Wilk test. Descriptive and analytical statistics were performed as needed. Significant level was set at p value ≤ 0.05.

3. Results

3.1. Demographic distribution

Data from the files of 270 patients with 476 maxillofacial fractures (The mean is 1.76 fractures for each patient) were analyzed. The age of the patients at the time of injury ranged from 2 years to 77 years old, with a mean of 24.29 years old (SD = 11.89). The majority of the patients (N = 241, 89.3%) were males, with a male to female (M/F) ratio of 8.3:1. The frequency of maxillofacial fractures was higher for men than for women in all age groups. Most of the patients were Saudis (N = 231, 85.6%). Only 39 patients (14.4%) were non-Saudis.

The most susceptible age group involved in the present study was young adult (19–44 years old) in both sexes, with a total of 177 patients (65.6%). Table 1 shows the distributions of the patients' age groups and gender.

3.2. Etiology of maxillofacial fractures

The most frequent cause of maxillofacial fractures in all patients (N = 270) was RTA, which accounted for 63.3% (171 patients), followed by falls (15.9, 43 patients). Fig. 1 shows the causes of maxillofacial fractures.

Table 1 Demographic distribution of maxillofacial fractures among different age groups and genders.

	Children ≤ 12 y	Adolescents 13–18 y	Young adults 19–44 y	Middle-aged 45–60 y	Elderly > 60 y
Males (n = 241)	12.9%	15.4%	66.4%	4.1%	1.2%
Females (n = 29)	10.3%	24.1%	58.6%	6.9%	0%

N = 270. Percentages are within the group of gender.

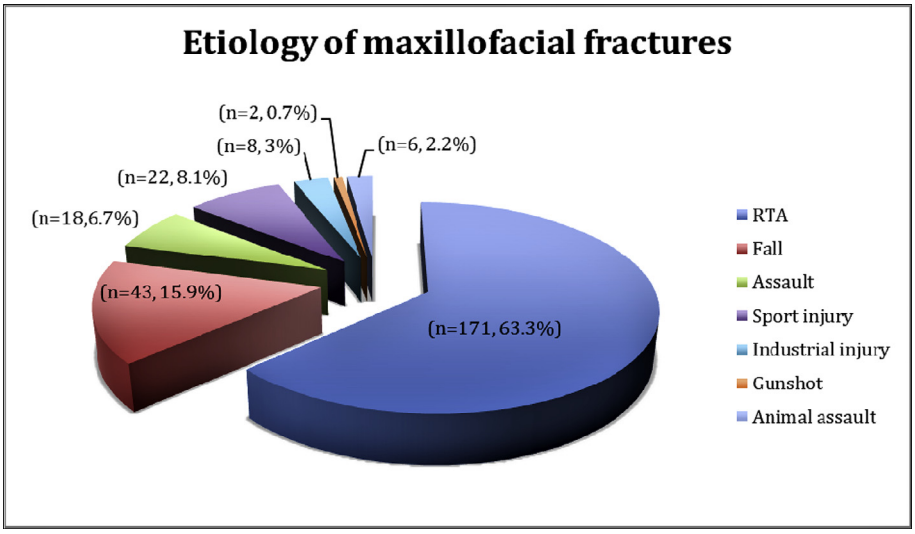

Fig. 1 Causes of maxillofacial fractures in 270 patients. n = number of patients.

3.3. Patterns of maxillofacial fractures

Most of the patients experienced single bone fractures (75.9%); multiple bone fractures were found in 24.1% of the subjects. The most common fractures were mandibular, with a total of 260 fractures (54.6%) in 167 patients (61.9%). The midface fractures accounted for 216 fractures (45.4%) in 141 patients (52.2%). The most common mid-facial fractures were zygomatic (37.4% of all patients, 71.6% of patients with mid-facial fractures), followed by orbital fractures (21.1% of all patients, 40.4% of patients with mid-facial fractures), maxillary fractures (11.9% of all patients, 22.7% of patients with mid-facial fractures), then naso-orbito-ethmoid (NOE) fractures (3.7% of all patients, 7.1% of patients with mid-facial fractures). Table 2 shows detailed distributions of various types of facial fractures.

The most frequent causes of mandibular fractures were RTA (66.5%), followed by falls (16.8%), assaults (7.8%), and sports injuries (5.4%). The most frequent causes of mid-facial fractures were RTA (66.4%), followed by falls (13%), sports (9.9%), and assaults (3.8%).

Table 2 Detailed distribution of maxillofacial fractures per type.

		Fractures	
		N	Percent
Fractures	Le Fort I	20	4.2%
	Le Fort II	18	3.8%
	Le Fort III	5	1.1%
	Palatal	1	0.2%
	ZMC fracture	86	18.1%
	Isolated zygomatic arch	19	4.0%
	Orbital	57	12.0%
	Naso-orbito-ethmoidal	10	2.1%
	Mandibular symphysis	24	5.0%
	Mandibular parasymphysis	64	13.4%
	Mandibular body	58	12.2%
	Mandibular angle	51	10.7%
	Mandibular ramus	4	0.8%
	Mandibular condylar process	56	11.8%
	Mandibular coronoid process	3	0.6%
Total		476	100.0%

Note: Percentages are of the total number of fractures.

3.4. Mandibular fractures

Among the 260 mandibular fractures, the parasymphyseal fracture was the most common (24.6%); Table 3 shows a detailed distribution of mandibular fractures. Only 25.8% of mandibular fractures were single and isolated. The majority of mandibular fractures (N = 193 fractures, 74.2%) were multiple and combined with other facial fractures. The mean age of patients who had mandibular fractures (M = 22.4 ± 10.9 years old) was significantly lower than those who had no mandibular fractures (p = .001, Mann-Whitney test). The common age group who had mandibular fracture was the young adult (61.7% of all mandibular fracture patients). No significant correlation was found between gender and the

Table 3 Distribution of mandibular fractures.

		N (n*) (n**)	Percent (% single) (% isolated)
Mandible	Symphyseal	24 (11) (9)	9.2% (46%) (38%)
	Parasymphyseal	64 (24) (20)	24.6% (38%) (31%)
	Body	58 (21) (18)	22.3% (36%) (31%)
	Angle	51 (18) (16)	19.6% (35%) (31%)
	Ramus	4 (0) (0)	1.5% (0%) (0%)
	Condylar process	56 (9) (4)	21.5% (16%) (7%)
	Coronoid process	3 (1) (0)	1.2% (33.3%) (0%)
Total		260 (84) (67)	100% (32.3%) (25.8%)

Total number of mandibular fractures (N = 260).
* n = count of single line fractures.
** n = isolated fractures (no other midface fractures).

presence of mandibular fractures (Pearson's chi-square test, p = .433).

3.5. Midface fractures

Among the 216 midface fractures, zygomatic fractures were the most frequent type, with 105 (48.6%) fractures, followed by orbital fractures (57 fractures, 26.4%), maxillary fractures (44 fractures, 20.4%), and naso-orbito-ethmoid (NOE) fractures (10 fractures, 4.6%).

Of the maxillary fractures, Le Fort I fracture was the most common (20 fractures, 45.4%). The mean age of patients with maxillary fracture (M = 31.1 ± 16.2 years old) was higher than those without (M = 23.4 ± 10.9 years old). The Mann-Whitney test showed a significant relationship between age in years and presence of maxillary fracture (p = .017).

The mean age of patients with zygomatic fracture (M = 27.2 ± 12.0 years old) was higher than those without (M = 22.6 ± 11.5 years old). The Mann-Whitney test showed a highly significant relationship between age in years and the presence of zygomatic fracture (p = .002).

There was no significant correlation between gender and any of the types of mid-facial fractures (p > 0.05, Fisher's exact test).

3.6. Combined facial fractures distribution

The most frequent facial fracture combination was zygomatic–orbital (n = 36 patients), followed by the zygomatic–mandibular fracture combination (n = 24 patients) and zygomatic–maxillary fracture (n = 17 patients). The most common mandibular fracture combination was parasymphyseal–condylar process fracture (n = 23 patients), followed by body–condylar process fracture (n = 16 patients).

4. Discussion

In the current study, males had a higher frequency of maxillofacial fractures than females did. This is comparable to studies done in other countries such as Iran with a ratio of 8.1:1 (Motamedi, 2003), and the United Arab Emirates with a ratio of 7.2:1 (Al-Khateeb and Abdullah, 2007). A much higher proportion of male patients than females (M:F = 10:1) was reported in Aseer city, southern Saudi Arabia (Almasri, 2013) and, in the United Arab Emirates (Ahmed et al., 2004), it was 11.1:1. This high frequency of maxillofacial fractures in males could be related to the fact that men are involved in more high-risk activities such as driving, occupation in construction or factory work, and sports activities that expose them to a higher risk for injuries. Furthermore, males are involved in physical social altercations more often than women. On the contrary, in countries such as Austria (Gassner et al., 2003) and Canada (Al-Dajani et al., 2015), the ratio of male to female patients who had maxillofacial fractures was low (2.1:1 and 1.6:1, respectively). This low ratio was attributed to the fact that females in those countries actively engage in social activities and, thus, are more liable to road traffic accidents, in addition to urban violence.

The most commonly involved age group in our study was young adults (19–44 years), accounting for 65.6% of patients, which was similar to the results of several other reviews from other countries, such as the Netherlands (Van Den Bergh et al., 2012), China (Mijiti et al., 2013), Italy (Arangio et al., 2014), Egypt (Mabrouk et al., 2014), and Nigeria (Adebayo et al., 2003). These findings most possibly reflect the higher physical activities and mobility seen in this young section of the population. Also, young adults usually pass through a demanding stage of their lives that involves self-determination; social enthusiasm, irresponsible driving, and they are more exposed to violent events.

This study showed that RTA constituted the most frequent cause of maxillofacial fractures. This result is similar to findings of other studies in Italy (Arangio et al., 2014), Turkey (Aksoy et al., 2002), the United Arab Emirates (Ahmed et al., 2004), Brazil (Brasileiro and Passeri, 2006), Pakistan (Cheema and Amin, 2006; Shaikh et al., 2014), India (Weihsin et al., 2014), Egypt (Mabrouk et al., 2014), and Iran (Kadkhodaie, 2006; Motamedi et al., 2014; Samieirad et al., 2015). In contrast to these findings, studies performed in Bulgaria (Bakardjiev and Pschalova, 2007), Korea (Lee et al., 2010), and Australia (Cabalag et al., 2014) reported assaults as the most frequent cause of maxillofacial fractures. In recent studies conducted at 13 European oral and maxillofacial surgery departments, the causes of maxillofacial injuries varies between centers, with assault and falls alternating as the most common causes: assaults were found the most frequent cause at 7 departments with overall rate of 39%; whereas falls were the most common in the remaining departments with overall rate of 31% (Boffano et al., 2015a, 2015b). Reasons for the dif-

ferences in the causes could be due to socioeconomic differences that exist between developed and developing countries. The decrease of maxillofacial fractures due to RTA in developed countries can be explained by the presence of better driving conditions, education and public awareness, and the presence of stringent traffic rules and regulations. This decrease in RTA in developed countries resulted in the emergence of interpersonal violence as the predominant etiological factor of maxillofacial trauma as a result of alcohol consumption and unemployment.

Although enforcement of traffic regulations is strict in various European and other countries, RTA still appears to be a significant cause of maxillofacial fractures worldwide, but more in Saudi Arabia compared to other countries. This may be attributed to several factors, including the availability of a high number of cars to very young people, high-speed driving, not using seat belts, and not following traffic regulations.

Fall was reported to be the most significant etiological factor of maxillofacial fractures in several other studies (Al-Dajani et al., 2015; Al-Khateeb and Abdullah, 2007; Cheema and Amin, 2006; Motamedi et al., 2014; Sasaki et al., 2009), which was also found in our study as the second most frequent cause of maxillofacial fractures. Fall in this study occurred mostly in children and preschoolers. Most falls occur in children because they are active and more prone to play accidents. In our study, sports injuries were found as the third most common etiological factor of maxillofacial fractures, affecting mainly male patients of young adult and adolescent ages. Females were not involved in maxillofacial fracture due to sports injuries, industrial injuries, or animal assaults because they are less exposed to such factors. In addition, females are usually more devoted to housework than outdoor activities.

In this study, the mandible was the most prevalent site for facial fractures in both genders (55%), followed by zygomatic fractures (22%). These findings are in agreement with the results of some other international studies, such as from Nigeria (Adebayo et al., 2003), Brazil (Brasileiro and Passeri, 2006), the United Arab Emirates (Al-Khateeb and Abdullah, 2007), urban Greece (Kostakis et al., 2012), the Netherlands (Van Den Bergh et al., 2012), Iran (Ansari, 2004; Mesgarzadeh et al., 2011; Motamedi et al., 2014), Pakistan (Cheema and Amin, 2006; Shaikh et al., 2014), and Egypt (Mabrouk et al., 2014). Similar to our results, the mandible followed by zygomatic bone fractures were also observed to be the most frequent maxillofacial fractures at several European centers (Boffano et al., 2015a, 2015b).

In contrast with our study, some other international studies reported different anatomical sites that were more exposed to maxillofacial injuries than the mandible. A report from Australia (Cabalag et al., 2014), indicated mid-facial fractures, especially Le Fort types and orbital floor fracture, as the most prevalent fractures. In Italy, zygomatic bone fracture was found to be the most common maxillofacial facial fracture in both genders, followed by mandibular fractures (Arangio et al., 2014). Nasal bone fractures were reported as the most frequently fractured site in Korea (Lee et al., 2010), followed by orbital wall, zygomatic bone, mandibular bone, and maxillary bone. The differences between different studies may be related to the mechanisms of injuries. Nasal bone fracture was excluded in our study as the hospital policy mandates these fractures to be seen and managed by the ENT department.

The most common mandibular fractured location in our study was the parasymphysis (25%), in agreement with those of a previous report in Iran (Samieirad et al., 2015). The second most prevalent mandibular fracture in this study was the body (22%) fractures, and similar findings were reported in studies conducted in Nigeria (Adebayo et al., 2003), Iran (Ansari, 2004), the United Arab Emirates (Al-Khateeb and Abdullah, 2007), and China (Mijiti et al., 2013). Another study found that condylar fractures were the most common (Kostakis et al., 2012), whereas they were found as the third most prevalent fractures of the mandible in our results, despite being frequent. This higher frequency of condylar process fractures might be due to the thin condylar neck, which makes it liable to fracture (Lee et al., 2017).

The most frequent anatomical location of mandibular fractures varied between different regions of Saudi Arabia. The parasymphyseal fracture was reported as the most prevalent mandibular fracture in Riyadh (Abdullah et al., 2013), a finding that is in agreement with our study, but the frequency was higher in Riyadh (47%). Another study conducted in Riyadh (Nwoku and Oluyadi, 2004) found a much higher frequency of angle fracture than other mandibular anatomical sites. In contrast to our results, Almasri in Aseer City (Almasri, 2013) reported condylar fracture as the most common mandibular fracture, followed by parasymphyseal fracture with minor differences in the frequency. The condylar fracture was also reported in Jeddah by Jan et al. (2015a, 2015b) as the most frequent mandibular fracture, followed by the body, whereas no parasymphyseal fracture was reported in that study. In Al-Medina, the mandibular body fractures were found to be the most frequent location (Rabi and Khateery, 2002), which were found the second most prevalent mandibular fractures in the present study.

The frequency of coronoid process and ramus fractures was very low in our study (1.2% and 1.5%, respectively), which is similar to studies from other regions of Saudi Arabia (Abdullah et al., 2013; Almasri, 2013). A relatively higher frequency of ramus fractures (13%) was reported, with no parasymphyseal or coronoid fractures, in Jeddah (Jan et al., 2015a, 2015b).

In our study, higher rates of mandibular fractures were combined with other facial fractures (74.2%), while only 25.8% were isolated. These findings contrast with reports from other studies (Al-Khateeb and Abdullah, 2007; Gandhi et al., 2011) where isolated mandibular fractures were most common than those combined with other facial fractures.

The most frequent mandibular fractures combination found in our study were parasymphyseal–condylar process fractures. The high rates of mandibular parasymphysis and condyle involvement could be attributed to the mechanism of injuries in RTA. Frequently, trauma from RTA involves a direct impact to the prominent chin that results in a force that transmits posteriorly to reach the condyles, leading to both parasymphyseal and condylar fractures (Almasri, 2013). Combination of mandibular parasymphysis and condyle fractures were reported the second most common in other studies (Aksoy et al., 2002; Gandhi et al., 2011; Van Den Bergh et al., 2012). In contrast to our finding, Aksoy et al. (2002) and Gandhi et al. (2011) found that the most common mandibular combined fractures were parasymphysis-angle

fractures. Van Den Bergh et al. (2012) found that the body of the mandible with the condylar process fractures to be the most frequent mandibular fractures combination, which was the second most common mandibular fractures combination in our findings.

Regarding mid-facial fractures, the majority of fractures were zygomatic, followed by orbital fracture, Le Fort I, Le Fort II, NOE, Le Fort III, and palatal fracture. This finding contrasts with a report from a local study (Nwoku and Oluyadi, 2004), where Le Fort II fracture was found the most frequent mid-facial fractures. In accordance with our results, most local studies (Abdullah et al., 2013; Jan et al., 2015a, 2015b; Rabi and Khateery, 2002) found zygomatic fracture to be the most frequent mid-facial fracture. Similar findings of numerous international studies reported the same (Al-Khateeb and Abdullah, 2007; Ansari, 2004; Arangio et al., 2014; Brasileiro and Passeri, 2006; Mesgarzadeh et al., 2011).

Few studies reported the frequency of facial fracture combinations. In our study, the most frequent facial fracture combination was the zygomatic bone with orbital fracture ($n = 36$) followed by zygomatic with mandibular fracture combination ($n = 24$). This may be explained by the fact that zygomatic bones are connected to the orbit, where any zygomatic fracture necessitates orbital wall involvement. Besides, both the mandible and the zygomatic bone are prominent parts of the face, which made them favorable sites for fracture. The combination of the zygoma and orbital rim fractures were also reported the most common midface combination fractures by Aksoy et al. (2002). On the contrary, Weihsin et al. (2014) found the mandible and zygomatic bone to be the most common combination, followed by the combination of the mandible and the nose. The combination of mandible and maxillary fractures was reported as the most frequent in a review (Cheema and Amin, 2006), followed by zygomatic bone and maxilla, then zygomatic bone and mandible.

In our study, we found no correlation between the gender of the patients with the causes of fracture, nor with the pattern. This may be related to the low number of females compared to male patients in our study. There was no significant relationship found between the causes of the fractures, orbital fractures, and NOE fractures with the age of the patients either. However, there were significant associations between the age of the patients and the presence of mandibular fractures, the presence of maxillary fractures, and presence of zygomatic fractures. One study reported a significant correlation between the etiology and gender, and between age and type of treatment (Samieirad et al., 2015).

5. Conclusions

RTA was the most common cause of maxillofacial injuries in Al-Ahsa, Saudi Arabia, and fall was the second most frequent. Males were more affected than females, especially young adults (19–44 years). These findings emphasize the need for better education of road safety and enforcement of traffic laws, especially for the most affected age group.

Excluding nasal bone fractures, mandibular fractures were the most common, followed by zygomatic fractures. The most common mandibular fracture was the parasymphysis, followed by the body and the condylar process. The parasymphysis–condylar process was the most frequent mandibular fracture combination. In the midface, zygomaticomaxillary complex (ZMC) fracture was the most frequent, followed by orbital walls and Le Fort I maxillary fractures.

Limitations of the study

- Lack of proper documentation and incomplete data in some patients' files.
- Nasal bone fractures and upper–facial third fractures were excluded from our study as ENT and neurosurgery departments, respectively, handle the management of these fractures, according to the hospital policy.
- All data from the present study were obtained from the records of the operating rooms, but some patients might have been seen and managed in the emergency department, the maxillofacial department, or in other hospitals to which they were referred and therefore omitted from our data.

Recommendations

In light of the findings of our study, the authors recommend the following.

- Call for more road safety protocols and traffic laws.
- Motivate better education about road safety, especially for the most susceptible age group (19–44 years).
- Construct a comprehensive preventive plan of facial fractures on the national level.
- A more extensive study with a large sample representing the whole country is recommended to have a clearer picture of the patterns of oral and maxillofacial injuries in Saudi Arabia.
- Initiate similar studies across different regions of the Kingdom of Saudi Arabia to establish a national protocol for maxillofacial trauma prevention and management.

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Conflicts of interest.

None declared.

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References

Abdullah, W.A., Al-Mutairi, K., Al-Ali, Y., Al-Soghier, A., Al-Shnwani, A., 2013. Patterns and etiology of maxillofacial fractures in Riyadh City, Saudi Arabia. Saudi Dent. J. 25, 33–38.

Adebayo, E.T., Ajike, O.S., Adekeye, E.O., 2003. Analysis of the pattern of maxillofacial fractures in Kaduna, Nigeria. Br. J. Oral Maxillofac. Surg. 41, 396–400.

Aksoy, E., Ünlü, E., Sensoz, Ö., 2002. A retrospective study on epidemiology and treatment of maxillofacial fractures. J. Craniofac. Surg. 13, 772–775.

Al Ahmed, H.E., Jaber, M.A., Abu Fanas, S.H., Karas, M., 2004. The pattern of maxillofacial fractures in Sharjah, United Arab Emirates: a review of 230 cases. Oral Surgery, Oral Med. Oral Pathol. Oral Radiol. Endodontol. 98, 166–170.

Al-Dajani, M., Quiñonez, C., Macpherson, A.K., Clokie, C., Azarpazhooh, A., 2015. Epidemiology of maxillofacial injuries in Ontario, Canada. J. Oral Maxillofac. Surg. 73, 693.e1–693.e9.

Al-Khateeb, T., Abdullah, F.M., 2007. Craniomaxillofacial injuries in the United Arab Emirates: a retrospective study. J. Oral Maxillofac. Surg. 65, 1094–1101.

Almasri, M., 2013. Severity and causality of maxillofacial trauma in the Southern region of Saudi Arabia. Saudi Dent. J. 25, 107–110.

Almasri, M., Amin, D., Aboola, A.F., Shargawi, J., 2015. Maxillofacial fractures in Makka City in Saudi Arabia; an 8-year review of practice. Am. J. Public Heal. Res. 3, 56–59.

Ansari, M.H., 2004. Maxillofacial fractures in Hamedan province, Iran: a retrospective study (1987–2001). J. Cranio-Maxillofacial Surg. 32, 28–34.

Arangio, P., Vellone, V., Torre, U., Calafati, V., Capriotti, M., Cascone, P., 2014. Maxillofacial fractures in the province of Latina, Lazio, Italy: review of 400 injuries and 83 cases. J. Cranio-Maxillofacial Surg. 42, 583–587.

Bakardjiev, A., Pschalova, P., 2007. Maxillofacial fractures in Southern Bulgaria – a retrospective study of 1706 cases. J. Cranio-Maxillofacial Surg. 35, 147–150.

Boffano, P., Kommers, S.C., Karagozoglu, K.H., Forouzanfar, T., 2014. Aetiology of maxillofacial fractures: a review of published studies during the last 30 years. Br. J. Oral Maxillofac. Surg. 52, 901–906.

Boffano, P., Roccia, F., Zavattero, E., Dediol, E., Uglešić, V., Kovačič, Ž., Vesnaver, A., Konstantinović, V.S., Petrović, M., Stephens, J., Kanzaria, A., Bhatti, N., Holmes, S., Pechalova, P.F., Bakardjiev, A.G., Malanchuk, V.A., Kopchak, A.V., Galteland, P., Mjøen, E., Skjelbred, P., Bertin, H., Marion, F., Guiol, J., Corre, P., Løes, S., Lekven, N., Laverick, S., Gordon, P., Tamme, T., Akermann, S., Karagozoglu, K.H., Kommers, S.C., Forouzanfar, T., 2015a. Assault-related maxillofacial injuries: the results from the European Maxillofacial Trauma (EURMAT) multicenter and prospective collaboration. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. 119, 385–391.

Boffano, P., Roccia, F., Zavattero, E., Dediol, E., Uglešić, V., Kovačič, Ž., Vesnaver, A., Konstantinović, V.S., Petrović, M., Stephens, J., Kanzaria, A., Bhatti, N., Holmes, S., Pechalova, P.F., Bakardjiev, A.G., Malanchuk, V.A., Kopchak, A.V., Galteland, P., Mjøen, E., Skjelbred, P., Koudougou, C., Mouallem, G., Corre, P., Løes, S., Lekven, N., Laverick, S., Gordon, P., Tamme, T., Akermann, S., Karagozoglu, K.H., Kommers, S.C., Forouzanfar, T., 2015b. European Maxillofacial Trauma (EURMAT) project: a multicentre and prospective study. J. Cranio-Maxillofacial Surg. 43, 62–70.

Brasileiro, B.F., Passeri, L.A., 2006. Epidemiological analysis of maxillofacial fractures in Brazil: a 5-year prospective study. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endodontol. 102, 28–34.

Cabalag, M.S., Wasiak, J., Andrew, N.E., Tang, J., Kirby, J.C., Morgan, D.J., 2014. Epidemiology and management of maxillofacial fractures in an Australian trauma centre. J. Plast. Reconstr. Aesthetic Surg. 67, 183–189.

Cheema, S.A., Amin, F., 2006. Incidence and causes of maxillofacial skeletal injuries at the Mayo Hospital in Lahore. Pakistan. Br. J. Oral Maxillofac. Surg. 44, 232–234.

Cornelius, C., Rudderman, R., Prein, J., Audigé, L., Kunz, C., Buitrago-téllez, C.H., Frodel, J., 2014. The comprehensive AOCMF classification system: mandible fractures-level 2 tutorial. Craniomaxillofacial Trauma Reconstr. Reconstr. 7, S15–S30.

Cunningham Jr, L.L., Haug, R.H., 2004. Management of Maxillary Fractures. In: Miloro, M. (Ed.), Peterson's Principles of Oral and Maxillofacial Surgery. BC Decker Inc, Hamilton, London, pp. 435–443.

Gandhi, S., Ranganathan, L.K., Solanki, M., Mathew, G.C., Singh, I., Bither, S., 2011. Pattern of maxillofacial fractures at a tertiary hospital in northern India: a 4-year retrospective study of 718 patients. Dent. Traumatol. 27, 257–262.

Gassner, R., Tuli, T., Hächl, O., Rudisch, A., Ulmer, H., 2003. Cranio-maxillofacial trauma: a 10 year review of 9543 cases with 21 067 injuries. J. Cranio-Maxillofacial Surg. 31, 51–61.

Gresele, A.D.P., Lessa, A.H., Alves, L.C., Torres, E.M.O., Vaucher, V., de Moraes, A.B., de Costa, J.M., 2013. Survey and data analysis of patients treated in a hearing aids grant program. Child. Deaf Adults 25, 195–201.

Hogg, N.J., Stewart, T.C., Armstrong, J.E., Girotti, M.J., 2000. Epidemiology of maxillofacial injuries at trauma hospitals in Ontario, Canada, between 1992 and 1997. J. Trauma 49, 425–432.

Jan, A., Alsehaimy, M., Al-Sebaei, M., Jadu, F., 2015b. A retrospective study of the epidemiology of maxillofacial trauma in Jeddah, Saudi Arabia. J. Am. Sci. 11, 57–61.

Jan, A.M., Alsehaimy, M., Al-Sebaei, M., Jadu, F.M., 2015a. A retrospective study of the epidemiology of maxillofacial trauma in Jeddah, Saudi Arabia. J. Am. Sci. 11, 57–61.

Kadkhodaie, M.H., 2006. Three-year review of facial fractures at a teaching hospital in northern Iran. Br. J. Oral Maxillofac. Surg. 44, 229–231.

Kostakis, G., Stathopoulos, P., Dais, P., Gkinis, G., Igoumenakis, D., Mezitis, M., Rallis, G., 2012. An epidemiologic analysis of 1,142 maxillofacial fractures and concomitant injuries. Oral Surg. Oral Med. Oral Pathol. Oral Radiol. 114, S69–S73.

Lee, J.H., Cho, B.K., Park, W.J., 2010. A 4-year retrospective study of facial fractures on Jeju, Korea. J. Cranio-Maxillofacial Surg. 38, 192–196.

Lee, C.W., Foo, Q.C., Wong, L.V., Leung, Y.Y., 2017. An overview of maxillofacial trauma in oral and maxillofacial tertiary trauma centre, Queen Elizabeth Hospital, Kota Kinabalu, Sabah. Craniomaxillofac. Trauma Reconstr. 10, 16–21.

Mabrouk, A., Mohamed, A.R., Mahmoud, N., 2014. Incidence, etiology, and patterns of maxillofacial fractures in ain-Shams University, Cairo, Egypt: a 4-Year retrospective study. Craniomaxillofacial Trauma Reconstr. 7, 224–232.

Majambo, M.H., Sasi, R.M., Mumena, C.H., Museminari, G., Nzamukosha, J., Nzeyimana, A., Rutaganda, E., 2013. Prevalence of oral and maxillofacial injuries among patients managed at a teaching hospital in Rwanda. Rwanda J. Heal. Sci. 2, 20–24.

Mesgarzadeh, A.H., Shahamfar, M., Azar, S.F., Shahamfar, J., 2011. Analysis of the pattern of maxillofacial fractures in north western of Iran: a retrospective study. J. Emergencies, Trauma Shock 4, 48–52.

Mijiti, A., Ling, W., Tuerdi, M., 2013. Epidemiological analysis of maxillofacial fractures treated at a university hospital, Xinjiang, China: a 5-year retrospective study. J. Cranio-Maxillofacial Surg., 1–7

Motamedi, M.H.K., 2003. An assessment of maxillofacial fractures: a 5-year study of 237 patients. J. Oral Maxillofac. Surg. 61, 61–64.

Motamedi, M.H.K., Dadgar, E., Ebrahimi, A., Shirani, G., Haghighat, A., Jamalpour, M.R., 2014. Pattern of maxillofacial fractures. J. Trauma Acute Care Surg. 77, 630–634.

Nwoku, A.L., Oluyadi, B.A., 2004. Retrospective analysis of 1206 maxillofacial fractures in an urban Saudi hospital: 8 year review. Pakistan Oral Dent. J. 24, 13–16.

Rabi, A.G., Khateery, S.M., 2002. Maxillofacial trauma in Al Madina region of Saudi Arabia: a 5-year retrospective study. Asian J. Oral Maxillofac. Surg. 14, 10–14.

Samieirad, S., Tohidi, E., Shahidi-Payam, A., Hashemipour, M.A., Abedini, A., 2015. Retrospective study maxillofacial fractures

epidemiology and treatment plans in Southeast of Iran. Med. Oral Patol. Oraly Cir. Bucal 20, e729–e736.

Sasaki, R., Ogiuchi, H., Kumasaka, A., Ando, T., Nakamura, K., Ueki, T., Okada, Y., Asanami, S., Chigono, Y., Ichinokawa, Y., Satomi, T., Matsuo, A., Chiba, H., 2009. Analysis of the pattern of maxillofacial fracture by five departments in Tokyo: a review of 674 cases. Oral Sci. Int. 6, 1–7.

Shaikh, M.I., Rajput, F., Khatoon, S., Usman, G., 2014. Etiology and Incidence of maxillofacial skeletal injuries at tertiary care hospital, Larkana, Pakistan. Pakistan Oral Dent. J. 34, 239–241.

Van Den Bergh, B., Karagozoglu, K.H., Heymans, M.W., Forouzanfar, T., 2012. Aetiology and incidence of maxillofacial trauma in Amsterdam: a retrospective analysis of 579 patients. J. Cranio-Maxillofacial Surg. 40, e165–e169.

Weihsin, H., Thadani, S., Agrawal, M., Tailor, S., Sood, R., Langalia, A., Patel, T., 2014. Causes and incidence of maxillofacial injuries in India: 12-year retrospective study of 4437 patients in a tertiary hospital in Gujarat. Br. J. Oral Maxillofac. Surg. 52, 693–696.