



ORIGINAL ARTICLE

Retrospective radiological evaluation to study the prevalence and pattern of maxillofacial fracture among Military personal at Prince Sultan Military Medical City [PSMMC], Riyadh: An institutional study

Zayed Ali Assiri ^{a,*}, Ra'ed Ghaleb Salma ^b, Emtenan Abdulrahmman Almajid ^c,
Alia Khalid Alfadhel ^d

^a Department of Oral and Maxillofacial Surgery, Saudi Ministry of Health, Aseer Region, Saudi Arabia

^b Department of Oral and Maxillofacial Surgery, Riyadh Elm University, Riyadh, Saudi Arabia

^c Department of Oral and Maxillofacial Surgery, Prince Sultan Military Medical City, Riyadh, Saudi Arabia

^d Department of Dentistry, Saudi Ministry of Health, Al Baha Region, Saudi Arabia

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KEYWORDS

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Abstract *Purpose:* The aim of the present study was to analyze the prevalence, causes, and patterns of maxillofacial fractures retrospectively in patients who were treated at Prince Sultan Military Medical City, Riyadh, Saudi Arabia.

Methods: Patients' medical records were reviewed from 2005 to 2014. Patient's age, gender, cause, and the pattern of maxillofacial fractures were studied. Associated body injuries were also recorded.

Results: Out of 263 patients, 207 (78.7%) were male and 56 (21.3%) were female. The age range was from 3 to 67 yr with a mean age of 26.21 yr. Road traffic accidents 236 (89.8%) were the most commonly reported cause of maxillofacial fractures, followed by falls 14 (5.3%), assaults 4 (1.5%), gunshot 3 (1.1%), and sport accidents 2 (0.8%). Most of the cases of maxillary fracture were Le Fort II 27 (36.5%), followed by LeFort I 23 (31.1%), LeFort III 20 (27.0%) and palatal fractures 4 (5.4%). Of the mandibular fractures, parasymphysis fractures constituted 61 (27.4%), body 50 (22.4%), condyle 45 (20.2%), angle 40 (17.9%), symphysis 16 (7.2%), ramus 7 (3.1%) and coronoid

* Corresponding author.

E-mail address: zayedali84@gmail.com (Z.A. Assiri).

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4 (1.8%). Zygomatic complex fractures 110 (94.8%) were the most commonly reported fractures in the mid and upper facial region. Other facial fractures included orbital floor 61 (97.0%), naso-orbito-ethmoidal 18 (19.8%), and frontal 12 (13.2%).

Conclusion: Road traffic accidents were the most common cause of maxillofacial fractures. Spreading awareness among young drivers regarding road safety regulations is highly recommended.

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1. Introduction

Oral and maxillofacial fractures refer to the fractures of facial skeleton, dento-alveolar bone and associated parts within the head and neck region due to external trauma. These fractures can lead to disabling function, non-aesthetic appearance and reduced quality of life (Majambo et al., 2013). The incidence of maxillofacial fractures differs from one country to another worldwide and even within the same country, and differences are reported depending on the dominant socio-economic, cultural, and environmental factors (Bogusiak and Arkuszewski, 2010). The reasons behind the high incidence of fractures of the craniofacial area are prominence of facial bones, position and anatomic configuration (Bereket et al., 2015). The causes of maxillofacial fractures have changed over recent decades and vary widely between different countries (Gadre et al., 2013). Road traffic accidents, falls, sports, domestic violence, assaults, suicide and gunshot injuries represent the leading causes of maxillofacial fractures (Gentile et al., 2013).

Road traffic accidents remain the major health problem throughout the world (Boffano et al., 2014). Saudi Arabia takes one of the leading place with regards to high mortality and morbidity (Ali Aba Hussein and El-Zobeir, 2007). The World Health Organization's (WHO) Global Status Report on Road Safety, showed that mortality because of road traffic accident per 100,000 population in Saudi Arabia is 22.7 (Al-Shammari et al., 2009). Speeding, violating traffic signals, abrupt lane change, and driver errors are common causes of road traffic accidents (Al Turki, 2014). A study of Sleep-related accidents among drivers in Saudi Arabia reported 33.1% had at least one near-miss accident caused by sleepiness. Among those who had actual accidents, 11.6% were attributed to sleepiness (BaHammam et al., 2014).

Injuries due to falling from heights are most commonly observed among toddlers and the elderly people (Iida et al., 2003). Soft tissue injuries such as abrasions, lacerations, tongue bites or tooth avulsions due to falls are common among young children (Hussain et al., 1994). On the contrary, elderly people sustain bone fractures, especially around the neck of the femur or they may sustain life-threatening head injuries (Kotecha et al., 2008). In Saudi Arabia, those aged 0–9 and 30–39 yr, falls were the most common cause of maxillofacial fractures (Abdullah et al., 2013). Similarly, another study conducted in Saudi Arabia among 9–11 yr old children the most common cause of trauma was due to falls and the most common types of injury were luxation injury and the complicated crown fracture (Al-Malik, 2009).

Facial fractures due to sporting have reduced over time because of better preventive measures. However, this reducing trend is counterweighting by the emergence of more risky

sports activities. The incidence of the fractures being most common in rugby and skiing followed by baseball and soccer (Tanaka et al., 1996). Sports account for 3–29% of facial injuries and 10–42% of facial fractures (Viozzi, 2017). Eleven-year review of maxillofacial fractures showed that 20% of the fractures in Western Europe were attributed to the sports, especially among males (Antoun and Lee, 2008). In Saudi Arabia sports related maxillofacial injuries ranged from 2.8% to 6.4% (Abdullah et al., 2013; Almasri, 2013).

Most of the developing countries are witnessing a rise in the violent assault and interpersonal violence. This condition is progressively unfolding in the changes in people's lifestyle. Young age people are the prime victims of drug, alcohol and other addictive substances. This lead to the higher incidence of assault related maxillofacial trauma (Hutchison et al., 1998).

The injuries sustained by the individual due to the animal attacks vary according to the types animals. Some injure infiltrative to the skin, whereas others may be blunt crash injuries. The domestic dog bite is the commonest animal attack among humans, and children under age of 10 yr were the most affected (Bolt and Watts, 2004). A review of the literature on animal bites among children has revealed that the most common site of injury was the face and the most frequently affected area was the middle third (55%), also called the "central target area." (Agrawal et al., 2017).

Maxillofacial injuries were seen to be a fundamental component of general body trauma attended to in emergency divisions of most of the hospitals. Both bone and soft tissue injuries of the Oral and Maxillofacial area are occasionally fatal while the survivors sustain disabilities and deformities that may compromise their quality of life if not adequately managed (Mansuri et al., 2015).

In 2013, the most frequent cause of death in Saudi Arabia was injury. According to Saudi Arabia's Ministry of Health, injury was implicated in 18.5% of deaths within the Kingdom. The societal repercussions of this public health issue are important as the loss of productive young persons to injury or death has serious consequences for Saudi families and the larger society as a whole (DeNicola et al., 2016). Annual expenditure is roughly Billions to treat road traffic-related injuries in Saudi Arabia, which constitutes the between 2, 2 to 9% of the national income.

An audit of maxillofacial injuries managed at the maxillofacial unit of Prince Sultan Military Medical City (PSMMC) was intended to show the burden of injuries on this institution in particular and the nation retrospectively. A Maxillofacial unit of PSMMC is one the major health institution in the Kingdom of Saudi Arabia with facilities to offer definitive management for such patients. The findings of this study may help as a reference point for future directions of

prevention and intervention measures in the management of patient protocol. Hence, the present study was undertaken to analyze the prevalence, causes, and patterns of maxillofacial fractures on the patients brought for treatment at the Prince Sultan Military Medical City, Riyadh, Kingdom of Saudi Arabia.

2. Materials and Methods

Ethical approval was sought from Research Ethic Committee (REC) at PSMC to obtain data retrospectively from patients with maxillofacial fractures that were treated surgically by open reduction and internal fixation (ORIF) in the Oral and Maxillofacial department at PSMC between 2005 and 2014. Data regarding all of the two hundred and sixty-three maxillofacial fracture cases were obtained from the medical charts of the Office of Operation Theater. The age (3–65 yr-old), gender, cause of injury, type and side of maxillofacial fractures involved, and associated fractures, if any, were included. Those excluded were patients with incomplete data or unclear records, patients not treated by the oral and maxillofacial team, patients admitted for reasons other than maxillofacial injuries such as dento-alveolar surgery, infection, and cleft lip or palate, and patients treated in the emergency room without admission.

2.1. Classification of maxillofacial fractures

Maxillary fractures were classified according to Le Fort classification: Le Fort I, Le Fort II and Le Fort III (Hopper et al., 2006). Mandibular fractures were classified according to Dingman and Natvig classifications (1969), which are based on the anatomical site: Symphysis, Parasymphysis, Body, Angle, Ramus, Condylar process, and Coronoid process (Edward and Luce, 1984). Zygomatic fractures were classified into a zygomatic complex fracture (ZMC) and isolated zygomatic arch (Van Den Bergh et al., 2012). Naso-orbital-ethmoid fractures (NOE), orbital fractures and frontal bone fractures were included and recorded as binary variables.

2.2. Statistical analysis

Data analysis was carried out using SPSS Statistics 21.0 software. Descriptive statistics of frequency distribution tables were generated for the categorical variables and mean standard deviations were calculated for the continuous variables. Fisher's exact tests was performed to establish the association between categorical variables. A p-value of ≤ 0.05 was considered statistically significant for all statistical purposes.

3. Results

3.1. Demographic data

In the present study, a total of 263 cases with maxillofacial fractures were studied. Two hundred and seven (78.7%) of the patients were male and 56 (21.3%) were female. The mean age was 26.21 yr (Male = 25.94 ± 10.03 yr, and Female = 26.48 ± 13.70 yr). The most affected age group were young adults between 21 and 30 yr (Table 1).

Table 1 Prevalence of maxillofacial fractures according to age and gender.

Age group (yr)	Gender		Total	
	Male	Female	n	(%)
0–10	11	4	15	(5.7)
11–20	41	16	57	(21.7)
21–30	93	21	114	(43.3)
31–40	44	6	50	(19.0)
≥ 41	18	9	27	(10.3)
Total	207	56	263	(100)

3.2. Causes

Table 2 shows the causes of maxillofacial fractures, which included Road Traffic Accidents (RTA) 236 (89.8%), falls 14 (5.3%), assaults 4 (1.5%), gunshot 3 (1.1%), sport accidents 2 (0.8%) and other causes 4 (1.5%).

3.3. Maxillary fractures

Out of 263 cases of maxillofacial fractures, 74 (14.7%) were related to the maxilla. As shown in Table 3 and Fig. 1, most of the maxillary cases were Le Fort II fractures 27 (36.5%), followed by Le Fort I 23 (31.1%), Le Fort III 20 (27.0%) and palatal fractures 4 (5.4%).

Interestingly, all of the Le Fort I and Le Fort III cases were due to RTA, while 26 (96.3%) Le Fort II fractures were due to RTA and 1 (3.7%) due to other causes. Similarly, 3 (75%) of the palatal fractures were attributed to RTA and 1 (25%) was caused by a fall (Table 4 and Fig. 2).

3.4. Mandibular fractures

A total of 223 (44.2%) mandibular fractures were reported. As shown in Table 3 and Fig. 3, among all the mandibular fractures, parasymphysis fractures constituted 61 (27.4%), body 50 (22.4%), condyle 45 (20.2%), angle 40 (17.9%), symphysis 16 (7.2%), ramus 7 (3.1%) and coronoid 4 (1.8%).

It was observed that RTA was the major cause of symphysis 15 (93.8%), parasymphysis 55 (90.2%), body 46 (92%), angle 36 (90%), ramus 5 (71.4%), condyle 39 (86.7%) and coronoid fracture 2 (50%). This was followed by falls which

Table 2 Causes of maxillofacial fractures.

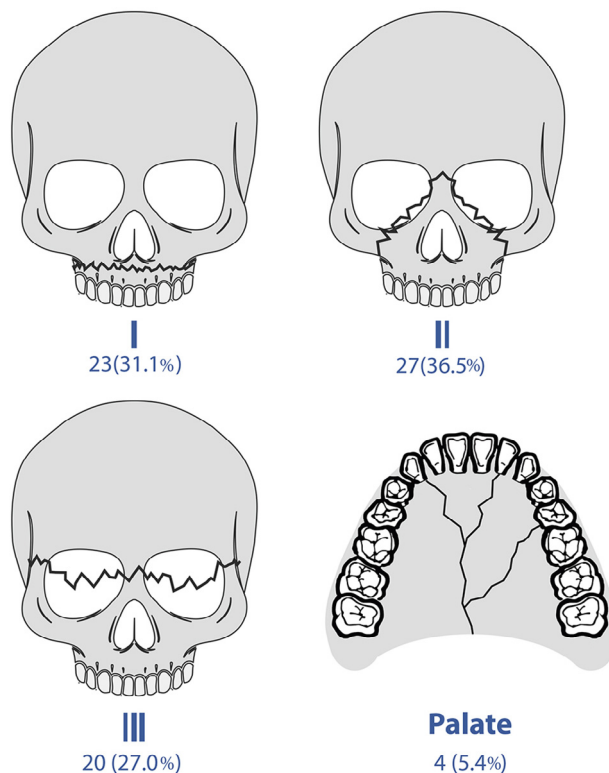
Cause	Gender		Total	
	Male	Female	n	(%)
RTA	187	49	236	(89.8)
Falls	11	3	14	(5.3)
Assaults	2	2	4	(1.5)
Gunshot	2	1	3	(1.1)
Sports	2	–	2	(0.8)
Other causes	3	1	4	(1.5)
Total	207	56	263	(100)

RTA: road traffic accident.

Table 3 Maxillofacial fractures distribution.

Fracture site		Gender		Total	
		Male	Female	n	(%)
Maxilla 74 (14.7%)	Le Fort I	18	5	23	(31.1)
	Le Fort II	22	5	27	(36.5)
	Le Fort III	17	3	20	(27.0)
	Palate	4	–	4	(5.4)
	Total	61	13	74	(100)
Mandible 223 (44.2%)	Symphysis	9	7	16	(7.2)
	Parasymphysis	45	16	61	(27.4)
	Body	38	12	50	(22.4)
	Angle	35	5	40	(17.9)
	Ramus	3	4	7	(3.1)
	Condyle	34	11	45	(20.2)
	Coronoid	4	–	4	(1.8)
	Total	168	55	223	(100)
Zygoma 116 (23.0%)	ZMC	90	20	110	(94.8)
	Isolated zygomatic arch	6	–	6	(5.2)
	Total	96	20	116	(100)
Others 91 (18.1%)	Orbital floor	48	13	61	(67.0)
	NOE	14	4	18	(19.8)
	Frontal	12	–	12	(13.2)
	Total	74	17	91	(100)

ZMC: zygomatic complex; NOE: naso-orbital-ethmoid.

**Fig. 1** Distribution of maxillary fractures.

resulted in symphysis 1 (6.3%), parasymphysis 6 (9.8%), body 1(5%), angle 2 (5%), coronoid 1 (25%) and condyle fracture 6 (13.3%). In addition, gunshot incidents resulted in 2 (4%)

body fractures and 1 (14.3%) ramus fracture, while assaults led to 1 (25%) coronoid fracture. Others injuries resulted in 1 (14.3%) ramus, 2 (5%) angle and 1 (2%) body fracture (Table 4 and Fig. 2).

3.5. Zygomatic fractures

Furthermore, it was observed that 116 (23%) fractures were related to the zygomatic region. In this type of fracture, ZMC were the most commonly reported fractures 110 (94.8%), followed by isolated zygomatic arch fractures 6 (5.2%), as shown in Table 3 and Fig. 4. More than half of the zygomatic fractures (51.3%) were bilateral in distribution, which reflects the severity of injuries.

RTA was the major cause for ZMC (99, 90%) and isolated zygomatic arch fractures (3, 50%). Falls resulted in 6 (5.5%) ZMC and 1 (16.7%) isolated zygomatic arch fractures. Assaults led to 3 (2.7%) ZMC and 1 (16.7%) isolated zygomatic arch fractures. Sports injuries and other causes resulted in 1 (0.9%) ZMC fracture (Table 4 and Fig. 2).

3.6. Other fractures

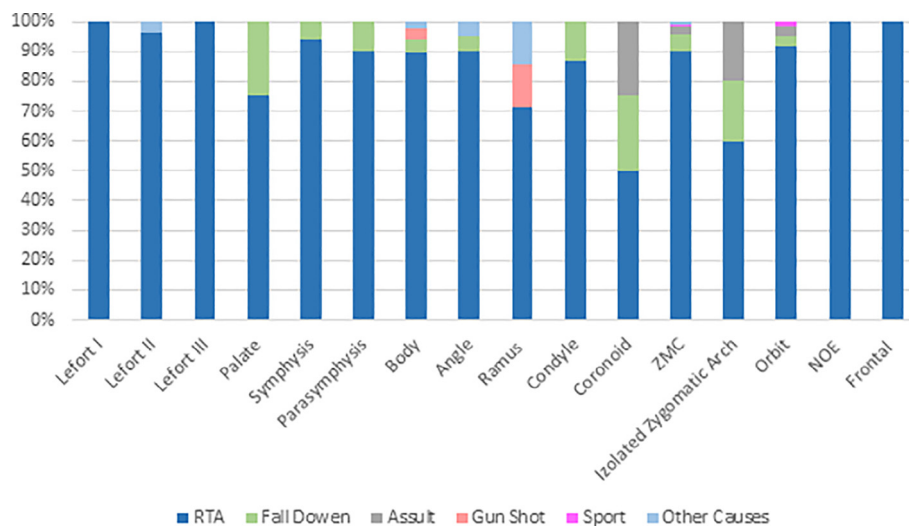
Other facial fractures included orbital floor 61 (29.5%), NOE 18 (8.7%) and frontal 12 (5.8%), as shown in Table 3 and Fig. 4.

RTA was the major cause of orbital 57 (93.4%), NOE 18 (100%) and frontal 12 (100%) fractures. Falls resulted in 2 (3.3%) orbital floor fractures. Assaults led to 2 (3.3%) orbital floor fractures. Sports injuries resulted in 1 (1.6%) orbital fracture (Table 4 and Fig. 2).

Table 4 Causes distribution according to fracture site.

Fracture site	Causes						Total n (%)
	RTA n (%)	Falls n (%)	Assaults n (%)	Gunshot n (%)	Sports n (%)	Other causes n (%)	
Le Fort I	23 (100%)	–	–	–	–	–	23 (100%)
Le Fort II	26 (96.3%)	–	–	–	–	1 (3.7%)	27 (100%)
Le Fort III	20 (100%)	–	–	–	–	–	20 (100%)
Palate	3 (75%)	1 (25%)	–	–	–	–	4 (100%)
Symphysis	15 (93.8%)	1 (6.3%)	–	–	–	–	16 (100%)
Parasymphysis	55 (90.2%)	6 (9.8%)	–	–	–	–	61 (100%)
Body	46 (92%)	1 (2%)	–	2 (4%)	–	1 (2%)	50 (100%)
Angle	36 (90%)	2 (5%)	–	–	–	2 (5%)	40 (100%)
Ramus	5 (71.4%)	–	–	1 (14.3%)	–	1 (14.3%)	7 (100%)
Condyle	39 (86.7%)	6 (13.3%)	–	–	–	–	45 (100%)
Coronoid	2 (50%)	1 (25%)	1 (25%)	–	–	–	4 (100%)
ZMC	99 (90%)	6 (5.5%)	3 (2.7%)	–	1 (0.9%)	1 (0.9%)	110 (100%)
Isolated zygomatic arch	3 (50%)	1 (16.7%)	1 (16.7%)	1 (16.6%)	–	–	6 (100%)
Orbital floor	57 (93.4%)	2 (3.3%)	1 (1.6%)	–	1 (1.6%)	–	61 (100%)
NOE	18 (100%)	–	–	–	–	–	18 (100%)
Frontal	12 (100%)	–	–	–	–	–	12 (100%)

RTA: road traffic accident; ZMC: zygomatic complex; NOE: naso-orbital-ethmoid.

**Fig. 2** Causes distribution according to fracture site.

3.7. Associated injuries

Out of all 263 maxillofacial fractures, 161 associated injuries were reported. The most common were long bone fractures 80 (49.7%), followed by head 51 (31.7%), chest 14 (8.7%), cervical spine 10 (6.2%), spine 5 (3.1%) and abdominal injuries 1 (0.6%), as shown in [Table 5](#).

3.8. Association between gender, age, and maxillofacial fractures

Fisher's exact test was performed to examine the association between gender, age and different types of maxillofacial fractures. None of the age or gender data was significantly associated with the occurrence of maxillary or zygomatic fractures. However, mandible shows a significant association only

between ramus fracture and gender ($p = 0.039$), with observations that males were less likely to have ramus fractures than females.

4. Discussion

In the present study the male to female ratio was approximately 4:1. Saudi Arabia's conservative culture, where men usually do outdoor work and no women drive, may explain these results ([Ahmed et al., 2004](#)). The higher incidence of maxillofacial fractures in males compared with females is in agreement with the findings of other studies conducted in Africa, North America and Brazil, Asia, Europe and Oceania ([Boffano et al., 2014](#)). In a study published by [Qudah and Bataineh \(2002\)](#) most of the patients were male 70%, with a male-to-female ratio of approximately 3:1. In [Gassner et al.](#)

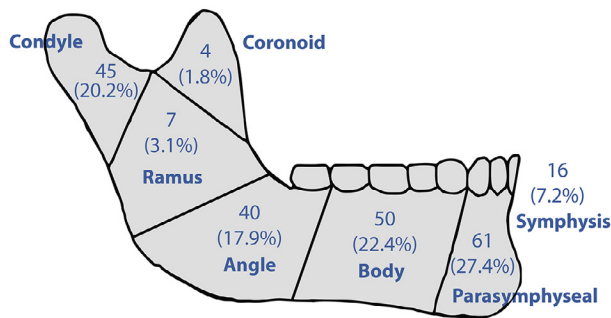


Fig. 3 Distribution of mandibular fractures.

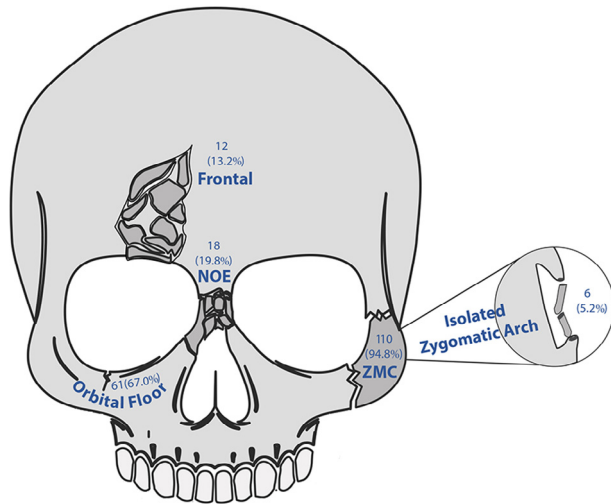


Fig. 4 Distribution of zygomatic & other facial fractures.

(2003) 78.2% of patients were male and 21.8% were female, with a male to female ratio of 3.6:1. Moreover, as reported by Singaram et al. (2016), 74.5% of incidents involved males and only 25.5% involved females, with a male to female ratio of 3:1. Similarly, Septa et al. (2014) showed that of all patients examined males represented 76% while females represented only 24%, with a male to female ratio of 3.16:1.

This study reported a mean age of 26.2 yr. Interestingly, it found that the highest number of individuals with maxillofacial fractures 43% were young adults between the ages of 21 and 30. Similarly, Batouk et al. (1996) conducted a study at Asir Central Hospital in Abha which also showed that the highest incidence of injuries occurs in the most active and productive age group (21–49 yr).

This study found that RTA was the main cause of maxillofacial fractures, followed by falls, assaults, gunshots, and sports injury; this is consistent with previous studies conducted in Jordan, Turkey, and Saudi Arabia where RTA was shown to be the primary cause of maxillofacial fractures, followed by falls, assaults, sporting and occupational injuries (Bataineh, 1998; Ozkaya et al., 2009; Abdullah et al., 2013). However, falling was the most common cause of injuries reported at the Department of Maxillofacial Surgery in Osijek (Siber et al., 2015). A study at Christchurch Hospital over an

Table 5 Associated injuries.

Associated injuries	Gender		Total	
	Male	Female	n	(%)
Long bone	66	14	80	(49.7)
Head	45	6	51	(31.7)
Chest	11	3	14	(8.7)
Cervical spine	8	2	10	(6.2)
Spine	2	3	5	(3.1)
Abdomen	1	–	1	(0.6)
Total	133	28	161	(100)

11-year period found that interpersonal violence was the main cause of maxillofacial fractures (Lee et al., 2007).

In the present study, the mandibular fracture was the most reported type of all fractures. Among all of the mandibular fractures, parasymphysis fracture was the most common type, followed by body, condyle, angle, symphysis and coronoid. Previous studies conducted in Saudi Arabia in the Asir region, Riyadh, Makkah, Jeddah, and Al-Medina showed that mandibular fractures were most common, which is similar to the findings of the present study (Almasri, 2013; Abdullah et al., 2013; Almasri et al., 2015; Jan et al., 2015; Rabi and Khateery, 2002). This confirms the fact that the mandible is the most prominent and the only movable facial bone, and hence has a higher chance of being fractured than a well-articulated mid-facial bone (Kumar et al., 2015).

Most of the Le Fort fracture cases in this study were Le Fort II fractures, followed by Le Fort I and Le Fort III. Similar findings were reported by Rabi and Khateery (2002) in Al-Medina, which showed a high incidence of Le Fort II fracture. On the contrary, Abdullah et al. (2013) showed that the Le Fort I fracture was more common than other Le Fort fractures in Riyadh.

The zygomatic region represents the second most commonly reported fracture in this study. ZMC fractures were the most commonly reported fractures in this anatomic region, followed by isolated zygomatic arch fractures. More than half of the zygomatic fractures were bilateral in distribution. The prominence of the zygomatic complex and its multiple articulations with other bones of the facial skeleton make it more prone to fracture when injuries affect the maxillofacial region (Ugboko et al., 2005). Similar to the present study, a report at King Saud Medical City showed that the zygomatic complex represents the highest number of injuries at mid-face (Abdullah et al., 2013). The higher prevalence of bilateral fractures in this study indicates the high severity of the injuries sustained. On the contrary, findings in a suburban Nigerian population showed 116 cases were unilateral and 12 were bilateral fractures, reflecting the less severe nature of the injuries (Ugboko et al., 2005).

The prevalence of frontal bone fracture has been reported to range from 5 to 15% of all maxillofacial trauma (Gerbinio et al., 2000; Marinheiro et al., 2014). Our findings showed a prevalence of 13% of frontal bone fractures, which is similar to previously mentioned studies. In a study in Makkah city the upper third (nasal, ethmoid, orbital, and frontal bar) fractures comprised 1.8% of all cases (Almasri et al., 2015), while

another conducted in Jeddah showed that out of 1650 fractures reported, 18 were NOE fractures (Jan et al., 2015).

In this study, out of all maxillofacial fractures 161 cases also reported associated injuries. Among these, long bone fractures were the most common, followed by head, chest, cervical spine, spine and abdominal injuries. The upper extremities are usually used by patients during trauma as protection against a facial trauma, while lower extremities are directly impacted by car accidents or falls (Scherbaum Eidt et al., 2013). In a study in India, Subhashraj et al. (2007) concluded that the most common associated injuries in patients with maxillofacial trauma were head injuries 39%, followed by orthopedic problems and cervical spine injuries. Rabi and Khateery (2002) reported that 40% of cases involved associated neurological problems due to the higher number of patients experiencing RTA, followed by 25% of cases with associated orthopedic injuries.

5. Conclusion

In conclusion, this study found that the majority of maxillofacial fractures are caused by RTA. A limitation of the study was that all the data were collected from a single center and hence the generalizability of the findings is limited. Further studies with larger sample sizes should be conducted including both private and government centers where maxillofacial trauma care has been provided. Furthermore, programs creating awareness among young drivers relating to road safety regulations is highly recommended in order to reduce the number of road accidents which lead to lifelong paralysis or death.

Declaration of Competing Interest

The authors declared that there is no conflict of interest.

Role of the funding source

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethical approval

The ethical approval and facilitating latter of this study were obtained from REC at Prince Sultan Military Medical City (ethic approval no. 996 dated 11.10.2017).

Patient consent

Not required.

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