



ORIGINAL ARTICLE

A cross-sectional study of the prevalence and severity of maxillofacial fractures resulting from motor vehicle accidents in Riyadh, Saudi Arabia

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KEYWORDS

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Abstract *Objectives:* To investigate the prevalence and severity of maxillofacial fractures resulting from motor vehicle accidents (MVAs) at King Abdulaziz Medical City (KAMC), Riyadh, Saudi Arabia.

Materials and methods: A cross-sectional study of 325 males (89%) and 47 females (9%) was conducted that retrospectively reviewed records of patients referred to oral and maxillofacial surgery department from emergency department from 1st January 2016 to 31st December 2017 at KAMC, Riyadh.

Results: A total of 372 subjects were included in the study. MVAs (80%) were the most prevalent cause of trauma. The age range most susceptible to MVAs was between 20 and 24 years old (28%). The most common site of fracture was the midface (64%), specifically orbit (32%). For mandibular fractures, the subcondylar was the most common site of fractures (19%). The most common treatment approach was conservative (65%). In terms of severity, approximately half of patients needed admission to the intensive care unit (ICU) (50%); the mean score on the Glasgow Coma Scale (GCS) was 11.34, but most scores fell in the mild range; and (68%) of subjects presented with other associated systemic injuries, especially orthopedic injuries (36%).

Conclusions: MVAs were the main cause of trauma and affected mainly young males. The most common site of fracture was midface, specifically orbit. Subcondylar was the most prevalent

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fracture site for mandibular fractures. The severity of MVAs injuries was significantly higher compared to non-MVAs injuries. We suggest enforcing legislation and regulations on road safety such as the use of compulsory seat belts.

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1. Introduction

Traumas caused by physical injury are the most common type of trauma and can occur for a variety of reasons (Samieirad et al., 2015). Considering the incidence of physical trauma and its deleterious impacts on individuals, they are among the world's most important health issues and are among the major causes of death among people under the age of 40 (Magruder et al., 2017). Physical injury is the most common cause of death in 2013 in Saudi Arabia (DeNicola et al., 2016). They can be due to different causes such as motor vehicle accidents, violence, sport injuries (Alqahtani et al., 2020).

Motor vehicle accidents (MVAs) are a well-known health hazard that can result in devastating morbidities which accounts for more than 1.27 million deaths worldwide and make up to 25% of all injuries each year, according to the World Health Organization (WHO) (World Health Organization, 2018). In Saudi Arabia, MVAs contribute 81% of mortalities to in-patients (Aldwsari et al., 2018). Despite the presence of laws and guidelines reinforcement, MVAs are still responsible for a greater number of hospital beds and considered to be the third major cause of death in Saudi Arabia (Memish et al., 2014). An accident takes place every minute in Saudi Arabia which result in 39,000 injuries and 7000 deaths per year (Touahmia, 2018). Studies have shown young male subjects are at higher risk to MVAs, and that could be mainly attributed to overconfidence and violation of traffic rules. MVAs are one of the most prevalent causes of trauma to the maxillofacial region that can be severe and life-threatening (Gaddipati et al., 2015).

Maxillofacial injuries are one of the most prevalent physical traffic-related injuries and the most prevalent victims are adult males (Singaram and Udhayakumar, 2016). In most parts of the world, the number of maxillofacial injuries is continuously increasing due to increasing traffic and failure to take preventive measures such as seat belts use, leading to motor vehicle accidents, which are considered the main etiological factor in maxillofacial fractures (Bali et al., 2013). Studies differ in their attribution of the most prevalent cause of facial trauma, and this variation can be affected by the various geographic regions and populations in which the studies were carried out (Abdullah et al., 2013). MVAs, however, remain the primary cause of facial trauma in Saudi Arabia (Samman et al., 2018; Scherbaum et al., 2013).

Variable patterns of maxillofacial trauma have been reported in literature. Mandibular fractures showed to be more prevalent than midface fractures as parasymphyseal, condylar, angle fractures were the most common affected sites in mandible (Abdullah et al., 2013). In respect to midface injuries, zygomatico-orbital complex, Le Fort I, and dentoalveolar fractures were prevalent (Ali-Alsuliman et al., 2018). The severity of maxillofacial injuries is complicated by the association with other systemic injuries, which can be a serious life-

threatening concern (Abosadegh et al., 2017). Concomitant serious injuries have been reviewed in the literature, and the most common injury associated with traumatic facial injury was traumatic brain injury (Chu et al., 2016). Furthermore, patency of airways can be affected by fractures, broken teeth, cervical edema, subconsciousness, and foreign bodies aspiration.

Addressing the prevalence and the severity of maxillofacial injuries is essential to establish prevention approaches and protocols. Facial injuries as a result of MVAs are preventable. Prevention strategies include and not limited to road safety policies and regulations, health education, safety equipment, and strict traffic monitoring. The aim of this study is to investigate the prevalence and severity of maxillofacial fractures resulting from MVAs at King Abdulaziz Medical City (KAMC), Riyadh, Saudi Arabia.

2. Materials and methods

2.1. Study design and setting

A retrospective cross-sectional chart review study, using the BESTcare system, was conducted at KAMC, Riyadh, Saudi Arabia, covering the period from 1st January 2016 to 31st December 2017. KAMC is a tertiary level one trauma center located close to the Riyadh–Dammam highway and receives numerous cases with acute injuries.

2.2. Study subjects and sample size

A total of 372 subjects were included in the study. The inclusion criterion was patients referred to the oral and maxillofacial surgery department from the emergency department. The exclusion criterion was patients with incomplete medical chart records.

2.3. Data collection

All patients' charts were reviewed, and the data was collated using Excel 2013. The following variables were extracted for each individual patient: date of trauma, age of patient, gender, cause of trauma, site of trauma, Glasgow Coma Scale (GCS) score, intensive care unit (ICU) admission, other associated injuries, and type of treatment provided. The date of the trauma, age of the patient, and GCS score were recorded as simple numerical data. Cause of trauma was recorded as MVAs and non-MVAs as falls, sports, violent assaults, and others.

Gender was recorded as either male or female, and ICU admission was recorded as either yes or no. Site of the trauma was recorded as one of four categories: midface, mandible, midface and mandible, or only soft tissue. Midface injuries

were subdivided into orbit, zygomatic bone, zygomatic arch, nasal bone, Le Fort I, Le Fort II, Le Fort III, and maxillary dentoalveolar. Mandibular injuries were subdivided into subcondylar, body, angle, mandibular dentoalveolar, symphysis, parasymphysis, condyle, ramus, and coronoid.

Association of other injuries was recorded as none or one or more of the following categories: orthopedic injury, brain injury, thoracic injury, cranium injury, cervical injury, and/or abdominal injury. Type of treatment provided was recorded and categorized as conservative, open reduction, or closed reduction.

2.4. Ethical considerations

Institutional Review Board (IRB) approval for the study was obtained from King Abdullah International Medical Research Center (KAIMRC). Confidentiality was maintained throughout the study as no subject identifiers were obtained.

2.5. Statistical analyses

Data was transferred to the Statistical Package for the Social Sciences (SPSS) version 20.0 (IBM Corp., Armonk, NY, USA) for statistical analysis. As frequencies and percentages (%), categorical variables were recorded. Continuous variables as means and standard deviations (SD) have been recorded. Student's *t*-test was used to test the difference between MVAs and non-MVAs cases in terms of GCS values. Chi-square test was used to analyze the association between MVAs and non-MVAs cases in terms of ICU admissions and other injuries associated. A *P*-value <0.05 was considered statistically significant.

3. Results

3.1. Baseline characteristics of the study subjects

A total of 400 patient records were retrieved. Twenty-eight patients were excluded due to missing or incomplete medical records. The remaining 372 patients were selected and reviewed. The most frequent cause of maxillofacial fractures

was MVAs, which accounted for 80%, followed by falls. Fig. 1 summarizes the etiologies of maxillofacial fractures.

Among the 295 patients who were admitted due to MVAs, 89% (262/295) were male and 11% (33/295) were female, indicating a ratio of approximately 9:1. The most common susceptible age range for MVAs and maxillofacial injuries was between 15 and 34 years old, representing 77% (228/295) of the sample, with the peak susceptible age between 20 and 24 years old, representing more than a quarter of the subjects 28% (84/295). The most common treatment approach for maxillofacial injuries resulting from MVAs was conservative 65% (192/295), followed by open reduction 30% (88/295) and closed reduction 5% (15/295).

3.2. Prevalence of maxillofacial fractures resulting from MVAs

See Fig. 2A–C

3.3. Severity of maxillofacial fractures resulting from MVAs

In terms of injury severity, the prevalence of death among MVAs cases was 5% (15/295) which indicates an accident to death ratio of approximately 20:1. 50% of the subjects (148/295) required ICU admission as a result of an MVA and 50% (147/295) did not. Most MVA patients had a GCS score in the mild range of "13–15" 60% (176/295), followed by the severe range of "3–8" 33% (98/295), and the moderate range of "9–12" 7% (21/295), with a mean score of 11.34. Most MVA patients presented with other significant associated injuries 68% (202/295), and the remainder 32% (93/295) did not.

Of the 381 associated injuries recorded, orthopedic injuries accounted for 36%, brain injuries for 25%, thoracic injuries for 14%, cranium injuries for 13%, cervical injuries for 7%, and abdominal injuries for 5%.

On analyzing the association between MVAs and non-MVAs cases in regard to GCS values, MVAs cases had a significantly lower GCS value of 11.34 compared to non-MVAs cases 14.18 (*P*-Value = 0.000). In addressing the significance between MVAs and non-MVAs cases in regard to ICU admissions, MVA cases had a significantly increased frequency to ICU admissions (50%) compared to non-MVAs cases (13%) (*P*-Value = 0.000). MVAs cases also had a significantly

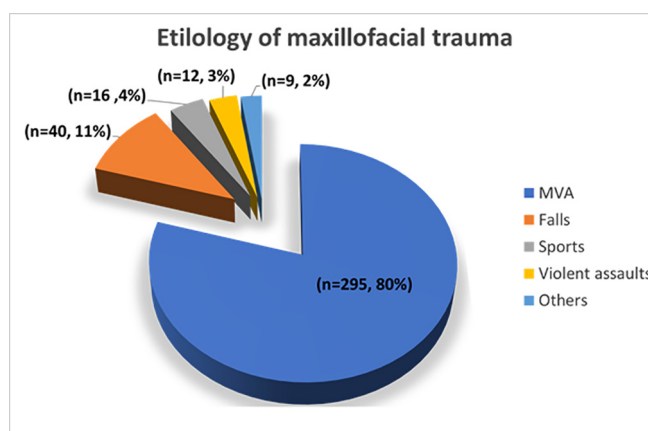


Fig. 1 Causes of maxillofacial fractures in 372 patients. n = number of patients.

increased frequency to other injuries (68%) compared to non-MVAs (30%) (P-Value = 0.000).

4. Discussion

Our study assessed the prevalence and severity of maxillofacial fractures resulting from MVAs at KAMC, Riyadh. MVAs (80%) were the most prevalent cause of maxillofacial fractures and facial trauma, comparable to other studies in Saudi Arabia. An Al-Ahsa study revealed that MVAs are the largest cause of maxillofacial trauma (63.3%) (Al-Bokhamseen et al., 2019). Another study conducted in Jeddah found MVAs to be the main cause of maxillofacial trauma (73.1%) (Alghamdi et al., 2017), and a study conducted by Singaram et al. found a similar rate (73.8%) (Singaram and Udhayakumar, 2016). A study in Australia, on the other hand, reported assaults as the major cause of maxillofacial injuries

(29.9%) (Cabalg et al., 2014). Another study undertaken in Germany showed that the primary cause of maxillofacial fractures is interpersonal violence (45.2%), followed by falls (25.2%), followed by MVAs (13.4%) (Schneider et al., 2015). This variation could be attributed to the different geographic regions and socio-economic status of the populations in which the studies were conducted; MVAs appear to be encountered more in low to middle income countries in Asia and Africa, and less in developed countries such as Australia, US and UK where there is increased awareness in the use of protective measures such as compulsory seat belts use and advancement in airbags technology (Hyman et al., 2016).

Our study showed a predominance of injuries to males (89%), with a gender ratio of 9:1. This appears to be in agreement with another study conducted in Saudi Arabia which reported similarly high rates of male subjects (91%) (Almasri, 2013). Other studies conducted in different countries

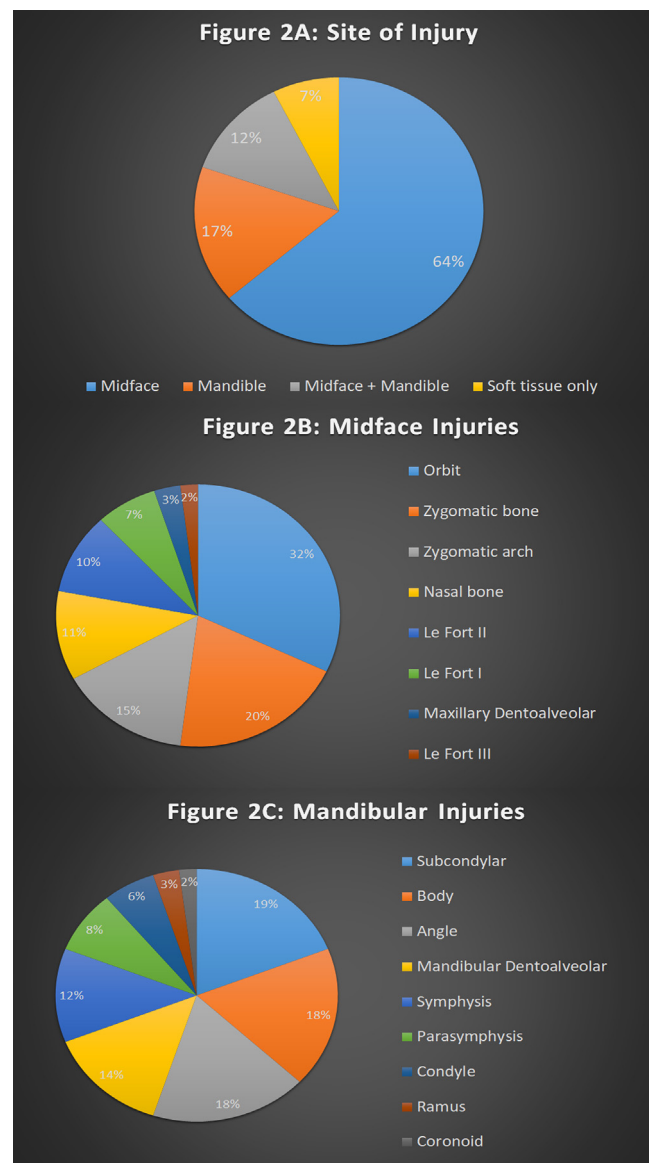


Fig. 2 A. Maxillofacial injury sites distribution as a result of motor vehicle accidents. B. Distribution of injuries in the midface region as a result of motor vehicle accidents. C. Distribution of injuries in the mandibular region as a result of motor vehicle accidents.

show different rates, with female subjects representing a greater proportion of subjects than in our study. For instance, an Indian study showed the percentage of male subjects to be (74.5%), giving a ratio of 4:1 (Singaram and Udhayakumar, 2016). The difference might be due to the culture in Saudi Arabia, with females not being allowed to drive at the time when the data was collected, and males utilizing motor vehicles as a primary means of transport and entertainment.

Reviewing the age distribution of MVAs victims, the majority were between the ages of 15 and 34, representing (77%) of the sample. Other studies conducted in Saudi Arabia have found similar age distributions (Al-Bokhamseen et al., 2019). Studies from other countries have reported comparable age groups (Schneider et al., 2015).

Conservative therapy for MVA victims was the primary therapy strategy (65%). Comparing our results to other studies, there is a difference in treatment modalities. A study in Netherlands reported open reduction and internal fixation to be the most commonly provided treatment (74%) (van Hout et al., 2013). In India, open reduction and internal fixation appeared to be the main treatment provided (34.5%) (Singaram and Udhayakumar, 2016). This difference in the provided treatment could be attributable to a preference for a conservative approach at the study's institution; conservative, rather than surgical, treatment might be provided if the patient's overall health is too unstable to receive surgical treatment; if the injuries do not require surgical intervention, such as non-displaced fractures or soft tissue injuries; or if the injury sites require intervention from other teams, such as cases of orbital and nasal bone injuries, which may require assistance from different specialties.

Our study showed that most injuries were located in the midface region (64%). Failure to wear seatbelt, airbag deployment, and the face hitting the steering wheel are possible explanations for this finding. In contrast, another study reported the mandible to be the most common maxillofacial injury, affecting (54.2%) (Almasri et al., 2015), which is an expected finding as people turn to their side when there is a direct sudden impact to the face, thus, the mandible being the most common region affected (Manodh et al., 2016). For the midface injuries, the current study suggested the orbit as the most common site for midface fractures (32%), followed by zygomatic bone fractures (20%). In our study, nasal bone fractures accounted for (11%), which is in consistent with other studies, as they are managed and treated by ear, nose, throat department, rather than oral and maxillofacial surgery (Ruslin., 2018).

Regarding mandibular injuries, our study suggested that subcondylar was the most common site for mandibular fractures (19%), followed by the mandibular body (18%). However, a study conducted in Chennai concluded that the most common fracture in the mandibular region was the parasymphysis region (12.2%), followed by condyle and angle regions (Manodh et al., 2016). This is in consistent with a research undertaken in Iran where parasymphysis was the most prevalent region for mandibular fractures (25.2%) (Samieirad et al., 2015). These findings suggest that these regions are the weakest in the mandible region.

In terms of severity, the current study showed an accident to death ratio to be 20:1, which was very similar to another study conducted in Saudi Arabia 32:1 and remarkably different than the ratio in USA of 283:1 (Mansuri et al., 2015). In

addition, the present study showed a high prevalence of associated injuries with MVAs (68%). The ratio of accident to injury in this study was about 8:6, compared with the international ratio of 8:1 (Ahmed et al., 2019). This study found that (50%) of MVA victims required ICU admission. A study conducted in Nigeria reported that the highest number of ICU admissions from 2008 to 2012 was traumatic brain injury following MVAs (Onyekwulu and Anya, 2015). The GCS scores of our subjects showed a mean of 11.34 on admission. Other studies have found different means, such as Gupta et al. who reported a higher GCS mean value of 14.18 (Gupta et al., 2015).

This study showed that orthopedic injuries (36%) were the most common injury type associated with MVAs, followed by brain injuries (25%). Comparably, a multicentre study found that brain and orthopedic injuries are the most commonly observed injuries associated with MVAs (Ruslin et al., 2018). A study conducted in New Delhi, India, (Gupta et al., 2015), showed that extremities injuries were the most commonly associated injuries, representing (40.8%), followed by head injuries (20.6%).

Our study findings showed that MVAs cases had a significantly increased frequency to ICU admissions, increased frequency of other injuries and decreased GCS values compared to non-MVAs cases. These observations reflect that MVAs are a serious public health issue with significant consequences on hospital resources and individuals' quality of life (van Hout et al., 2013).

5. Study limitations

The main limitation of this study was the lack of literature on the topic, especially in Saudi Arabia. The study was conducted over a duration of two years in a single trauma center in Saudi Arabia; consequently, the results of this study can not be generalized. Further studies can be carried out to involve more centers and to include longer study periods. Also, further local studies are recommended to be conducted prospectively to provide an insight of possible new patterns in the main causes of maxillofacial trauma after the extensive seatbelts use and improvement of road traffic conditions.

6. Conclusions

In conclusion, MVAs were the main cause of trauma and affected mainly young males. The most common site of fracture was midface, especially orbit. For mandibular fractures, subcondylar was the most common site of fracture. The comments type of management to those fractures was conservative treatment. Half of the patients required ICU admission. Most victims fell in the mild range of GCS. The majority of subjects presented with other associated systemic injuries, particularly orthopedic injuries.

Ethical committee approval

Ethical approval was obtained from King Abdullah International Medical Research Centers (KAIMRC). IRB Approval number (SP18/056/R).

Informed consent

N/A.

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Declaration of Competing Interest

None.

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