Original Article

Associated head injuries and survival rate of patients with maxillofacial fractures in road traffic accident: A prospective study in Saudi Arabia

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Abstract

Background: Every minute, an accident occurs in Saudi Arabia, causing 39,000 injuries and 7,000 deaths annually. Facial trauma or maxillofacial trauma (MFT) is a frequent presentation of road traffic accidents (RTAs), ranging from simple nasal fractures to gross or severe maxillofacial injuries. **Methods:** A total number of 237 patients were included in this prospective study from May 2013 to January 2018. The following medical details were recorded for each case, gender, age, fracture location, the presence of scalp laceration, the presence of brain damage, type of brain damage, shock degree, Glasgow Coma Scale (GCS), number of units used for blood transfusions for documentation of patient survival rate. We followed up the patients in their first appointment after 21 days of patient discharge from the hospital. **Results:** Majority of the patients were young male adults. A total of 59.1% of patients had cerebral damage, 38% (n = 90) of patients had at least, one scalp laceration, 43.5% (n = 103) of patients had some degree of shock, whereas 27.8% of the recruited patients needed at least 1 unit of blood transfusion. A total of 14.3% of the patients died as a result of their injuries, and the survival rate was 85.7%. **Conclusions:** Kingdom of Saudi Arabia (KSA) is having a high incidence of RTAs leading to high mortality rate. Therefore, it requires a sound evaluation of the risk factors for RTAs and establishment of guidelines to decrease the incidence of road traffic injuries and reduce health-care burden. Road safety campaigns focused on young population can help reduce RTAs and subsequent mortalities. Prompt arrival at the hospital, early diagnosis, and timely management of maxillofacial fractures and brain damages by skilled physicians will lower mortality rate in KSA..

Keywords: Fracture, head injury, maxillofacial, road traffic accidents

Introduction

Road traffic accident (RTA) is one of the major contributors to mortality and morbidity, accounting for more than 1.27 million deaths globally.[1] World Health Organization (WHO) has reported that road traffic crashes make up to 25% of all injuries. In the Kingdom of Saudi Arabia (KSA), RTAs contribute 81% of deaths to hospitalized patients.[2] In spite of active enforcement of rules and regulations, RTIs (road traffic injuries) are still occupying a larger number of beds in tertiary care hospitals. Every minute, an accident occurs in KSA, causing 39,000 injuries and 7,000

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deaths annually.[3] Facial trauma or maxillofacial trauma (MFT) is a frequent presentation of RTAs, ranging from simple nasal fractures to gross or severe maxillofacial injuries.[4] Mandible fracture is the most common fracture in MFT in KSA.[5] The management of severe MFT is extremely challenging, increasing an extra burden on health system on the nation.

KSA is a vast, high-income country having a population of more than 27 million people. The primary source of transportation is motor vehicles. Therefore, approximately 6 million cars are found on the roads of Saudi Arabia.[6] KSA has rapid economic growth, which made it construct additional roads and buy vehicles. Therefore, KSA is included among top countries having a high incidence of RTAs. There is a significant number of factors contributing to RTAs including human factors, road conditions, and vehicle defects. However, the prevalence of RTIs varies by age, education, occupation, climate, geography, poor eyesight, ethnicity, culture, inadequate safety measures, long hours driving, inadequate driving skills, abnormal health conditions, violation of rules, and lack of legislation. In KSA, 65% accidents happen due to driving errors, especially among the young ones.[7] Overconfidence and violation of traffic rules and regulations are the main factors of driver-related RTAs among the young people.

KSA is also a center of the Muslim world where a large number of people come every year for pilgrimage. These multicultural and multilingual people contribute to the high traffic on roads, facing problems in understanding traffic rules and regulations, especially in the holy cities of Makkah and Medina, where many people visit every year from all over the world. A study has shown an increased incidence of RTIs among non-Saudis as compared to Saudi people, which raises a question to investigate the causes and factors. Accidents in KSA cause loss of 2.29% of the national income.[2]

Young and economically active people are more at risk of RTAs.[8] Studies have shown that most victims are males, aged 45 years or younger. At the time of study only males where allowed to drive in Saudi Arabia; so males experience most of the RTIs.[9] In young people, high speed is the most common cause of RTAs. A study revealed that head injuries and MFT account for 30% of all injuries, contributing 26% deaths in KSA.[10]

Abdullah *et al*. conducted retrospective review on pattern and etiology of maxillofacial fractures in Riyadh City including 237 patients admitted to the King Saud Medical City Dental Department with a diagnosis of MFT.[11] They reported motor vehicle accidents as the most common cause of MFT, especially among males (10–29 years). However, etiology and incidence of MFT vary by country, education status, socioeconomic status, and cultural characteristics. In the study by Abdullah *et al*., mandible fractures (56.4%) were the most common fractures followed by condylar fractures (43.6%). Similarly, Mazen has reported RTAs as a major cause of MFT, demonstrating that motor vehicle accidents put a heavy burden on health care in the Southern region of Saudi Arabia.[5]

Multiple fractures can complicate the management of severe MFT and compromised the airway. In MFT, the airway can be complicated by broken teeth or dentures, foreign objects, numerous fractures, massive cervicofacial edema, altered level of consciousness, drug intoxication, and aspiration. Most importantly, airway patency is at risk when fractured facial bones are displaced posteriorly, for example, maxilla or mandible bones. In KSA, MFT is managed with open reduction and rigid internal fixation or closed reduction and nonrigid fixation. The average hospital stay of the patients with MFT is 10.4 days. As complications may be encountered in every surgery, maxillofacial surgery also faces aftereffects. Jan *et al*. reported complications in 18% patients with MFT including esthetic deformities, sensory disturbance, infection, and malocclusion.[12] Mortality rate of MFT varies in different regions of the world depending on the severity of trauma, concomitant head intracranial injuries, and quality of health-care system.

RTAs are a preventable cause of mortality, morbidity, depression, loss of employment, and many other health-related issues. This prevention requires organized guidelines and activities in the form of counseling, safety weeks, and electronic media campaigns. In a country with adequate funds like KSA, strict traffic monitoring, seat belt legislation, well-equipped trauma centers, and fast ambulance service can reduce a great burden on the health-care system. Additionally, a committee analyzing the frequency of RTIs, people prone to TRAs and research, can help in developing guidelines to prevent MFT.

This study is aimed at determining the prevalence of associated head injuries and survival rate of patients with maxillofacial fractures in RTA with respect to age, gender, mortality, the location of skull fracture, brain damage, altered level of consciousness, scalp laceration, and shock. There is no such an extensive study available from KSA. Hence, this study will be a valuable addition to the literature.

Aims and objectives

1. Prevalence of mortality in patient with maxillofacial fractures in RTA
2. Investigate the relationship between maxillofacial fractures location and brain damage
3. Common associated head injuries with maxillofacial fractures
4. Widespread of shock degree in patients with maxillofacial fracture
5. Association between GCS and types of brain damage caused by maxillofacial fracture.

Material and Methods

Study design

Prospective cohort study.

Study population

Patients with maxillofacial fracture caused by RTA with a nonpenetrating head injury who are present at the hospital between May 2013 and January 2018 were included in the study.

Sample size: 236 patients.

A total number of 236 patients were included in this study between May 2013 and January 2018. This prospective study was conducted at King Khalid Hospital and Prince Sultan Center for Health Services in the KSA. The ethical committees of the hospital approved the study. The personal and medical information of all patients stayed highly confidential and used for the sake of this study only. All patients in this study had at least one fractured maxillofacial bone due to RTA. We obtained a written informed consent from all patients. Patients' family gave the written informed consent in case of mortality and underage children. The following medical details were recorded for each case, gender, age, fracture location, the presence of scalp laceration, the presence of brain damage, type of brain damage, shock degree, Glasgow Coma Scale (GCS), and the number of units used for blood transfusions. We used both computed tomography scan (CT scan) and plain x-ray to assess the fracture location. Magnetic resonance imaging (MRI) was used for assessment of brain damage. For documentation of patient survival rate, we followed up the patient in their first appointment after 21 days of patient discharge from the hospital. In case the patient did not show up for the appointment, we tracked his ID with the Ministry of Health looking for the death certificate. Strictly, only subjects with official death certificate documentation were recorded as dead. The following patients were excluded from the study sample:

A. Patients without maxillofacial fractures
B. Incomplete medical records
C. Patients with maxillofacial fractures due to causes other than RTA (e.g., pathological fracture, occupational accident, gunshot accident, etc.)
D. Failure to obtain the patient consent
E. Death occurred before reaching the hospital
F. Patient with penetrating head injury.

All other patients with maxillofacial fracture caused by RTA with a nonpenetrating head injury that came to the hospital between May 2013 and January 2018 were included in the study after we obtain a valid informed consent. We completed the data collection in January 2018.

Results

A total number of 237 patients were recruited into this study, which aimed to review the associated head injuries and survival rates of patients with maxillofacial fractures in RTAs. The majority of patients considered for this study were adults (n = 191), of which some were young adults (21–30 years of age) prevailed (n = 102). Male patient represents 97.5% of cases whereas females were 2.5%. The clinical presentation of all 237 patients was also reviewed to provide a holistic indication of the severity of the injury. A total of 59.1% of patients (n = 140) had MRI proven cerebral damage, 38% (n = 90) of patients had at least one scalp laceration, and 43.5% (n = 103) of patients had some degree of shock. Furthermore, 27.8% of the recruited patients needed at least 1 unit of blood transfusion. Reference can be made to Table 1 and Figure 1 for a more detailed demographic breakdown of the cohort used for this study.

The association between fractured craniofacial bones and MRI proven cerebral damage was observed in this study. The incidence of cranial bone and facial bone fractures was measured along with the prevalence of MRI-proven brain damage. The specific types of brain damage were also observed. The incidence of occipital and sphenoid bone fractures was relatively low, at 1.7% and 1.2%, respectively. Temporal, parietal, and frontal bone fractures, however, displayed higher incidences of 13.9%, 18.6%, and 12.2%, respectively. Among the facial bone fractures, bicondylar and parasymphyseal bone fractures had relatively low incidences of 1.7% each. The other facial bone fractures were observed to have modest occurrences, with the maxillary sinus, orbital wall, and mandibular fractures ranking chiefly at 12.3%, 9.2%, and 7.6%, respectively. Reference can be made to Figures 2 and 3 below to visualize the individual prevalence of MRI-proven brain damage concerning the type of fracture sustained.

The Pearson Chi-square test was used to objectively measure the association between the aforementioned fractured craniofacial bones and MRI-proven brain damage. The results suggest that there is an association between orbital wall, temporal, parietal, and frontal bone fractures with brain damage. This is supported by the calculated P values for each of these cranial bone fractures

Table 1: Percentage and frequency of age, brain damage, scalp laceration, shock degree, and blood transfusion

	Frequency (%)
Age category	
1-10	7 (3.0)
11-20	39 (16.5)
21-30	102 (43.0)
31-40	56 (23.6)
41-50	11 (4.6)
51-60	22 (9.3)
Brain damage	
Yes	140 (59.1)
No	97 (40.9)
Scalp laceration	
No	147 (62.0)
Yes	90 (38.0)
Shock degree	
1st	62 (26.2)
2nd	34 (14.3)
3rd	7 (3.0)
No shock	134 (56.5)
Blood transfusion	
1 unit	13 (5.5)
2 units	39 (16.5)
5 units	14 (5.9)
Non	171 (72.2)

(0.001, 0.000, 0.000, and 0.000, respectively). The P value for occipital bone fractures was 0.015; however, as the sample size was less than 5, the Chi-square results may not be reliable. The individual Chi-square values and their significance is displayed in Table 2 below.

The results do not support an association between facial bone fractures and brain damage. This is suggested by the calculated P values of the maxillary sinus, zygomatic arch, mandibular, and nasal bone fractures (0.119, 0.246, 0.855, and 0.130, respectively). There may yet be an association between occipital, parasymphyseal, bicondylar, and sphenoid bone fractures with brain damage, but our results do not support it. This may be due to the small sample size of less than 5, for each of these facial bone fractures, which may discredit their calculated P values. Future studies looking to establish a definitive association between facial bone fractures and brain damage might recruit a larger pool of patients to circumvent this problem.

The types of brain damage sustained by 140 of 237 patients recruited for this study, was stratified by type. Fifteen types of MRI-proven brain damage were observed in this cohort. Among them are brainstem hemorrhage contusion, epidural hemorrhage, and subarachnoid hemorrhage that ranked chiefly with a prevalence of 32.9%, 28.3%, and 24.9%, respectively. The individual prevalence of each of the 15 types of documented MRI-proven brain damage can be visualized in Figure 4. The severity of brain damage incurred by 140 patients was correlated with their Glasgow Coma Scale (GCS), which is used clinically to assess one's level of consciousness. The Spearman's rank-order correlation was used to measure the strength of association between GCS and the type of brain damage incurred. The results suggest a significant relationship between periorbital edema, subdural hemorrhage, subgaleal hematoma, and intraventricular hemorrhage and GCS with P values of 0.001, 0.013, 0.010, and 0.018, respectively. The association between GCS and the other types of brain damage incurred was not established by our results, as their P values were insignificant. The GCS Spearman correlation coefficient and the individual significance of each of the 15 types of brain damage can be referenced in Table 3.

Another aim of this study is to assess the patient outcomes for maxillofacial fractures as a result of RTAs. All 237 patients recruited for this study were followed up for 21 days after they were discharged from the hospital. Of 140 patients who sustained MRI-proven brain damage, 14.3% ($n = 20$) of them died as a result of their injuries. Reference can be made to Figure 5 for visualization of the prevalence of mortality in patients with craniofacial fractures in RTA.

Table 2: Correlation between craniofacial fracture and brain damage

	Brain damage		Total	Pearson Chi-square		
	Yes	No		Value	df	P
Maxillary sinus						
Count	21	8	29	2.433[a]	1	0.119
Percentage of total	8.9	3.4	12.2			
Orbital wall						
Count	20	2	22	10.167[a]	1	0.001**
Percentage of total	8.4	0.8	9.3			
Occipital						
Count	0	4	4	5.872[a]	1	0.015*,[b]
Percentage of total	0.0	1.7	1.7			
Temporal						
Count	31	2	33	19.279[a]	1	0.000**
Percentage of total	13.1	0.8	13.9			
Zygomatic arch						
Count	11	4	15	1.347[a]	1	0.246
Percentage of total	4.6	1.7	6.3			
Parietal						
Count	39	5	44	19.534[a]	1	0.000**
Percentage of total	16.5	2.1	18.6			
Mandible						
Count	11	7	18	0.034[a]	1	0.855
Percentage of total	4.6	3.0	7.6			
Parasymphyseal						
Count	0	4	4	5.872[a]	1	0.015*,[b]
Percentage of total	0.0	1.7	1.7			
Frontal						
Count	27	2	29	15.829[a]	1	0.000**
Percentage of total	11.4	0.8	12.2			
Bicondyler						
Count	0	4	4	5.872[a]	1	0.015*,[b]
Percentage of total	0.0	1.7	1.7			
Nasal						
Count	13	4	17	2.293[a]	1	0.130
Percentage of total	5.5	1.7	7.2			
Sphenoid						
Count	1	2	3	0.833[a]	1	0.362b
Percentage of total	0.4	0.8	1.3			

*Indicates $P<0.05$, **Indicates $P<0.01$, [a]Indicates number of cells having expected count less than 5 and the minimum expected count, [b]Indicates standardized statistics

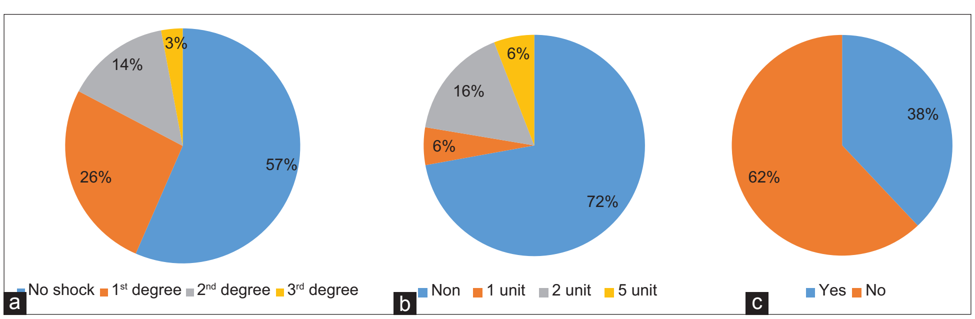

Figure 1: (a) Shock degree. (b) Blood transfusion. (c) Scalp laceration

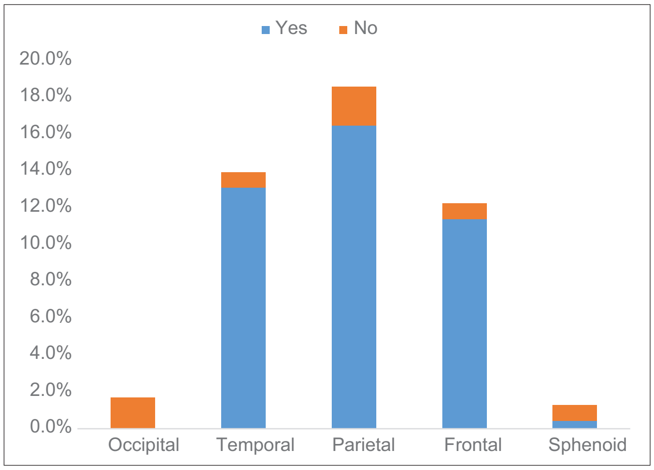

Figure 2: Cranial bones and brain images

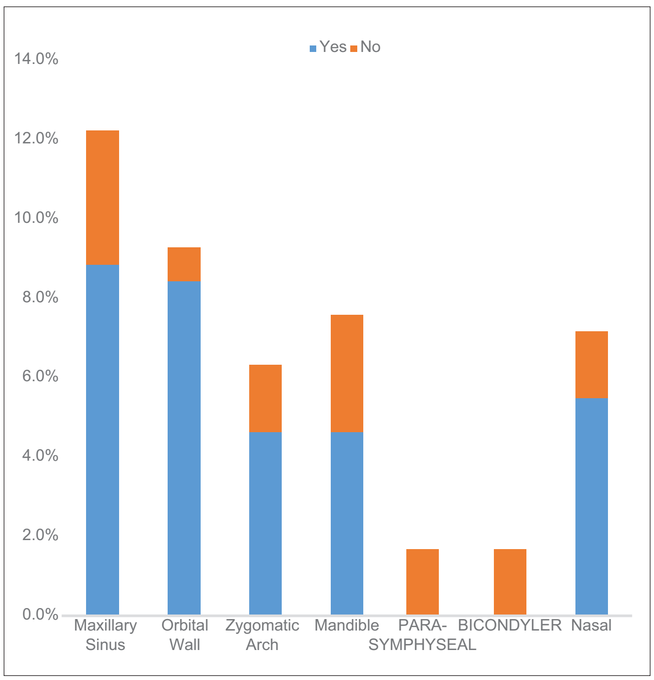

Figure 3: Facial bones and brain damage

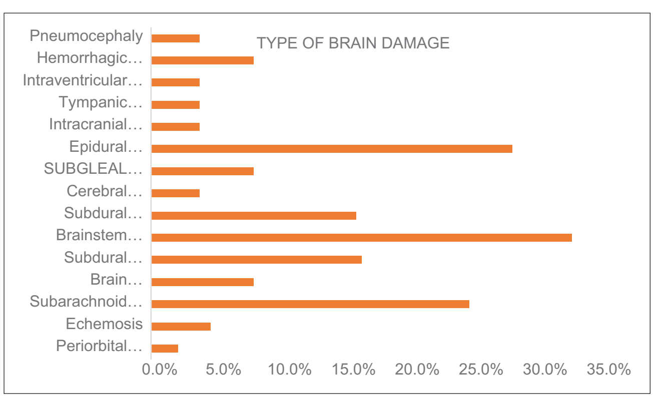

Figure 4: Type of brain damge

Table 3: Correlation between Glasgow Coma Scale and type of brain damage

	GCS spearman correlation		
	n	Correlation coefficient	Significant (two-tailed)
Periorbital edema	140	0.283**	0.001**
Ecchymosis	140	0.127	0.135
Subarachnoid hemorrhage	140	−0.157	0.063
Brain edema	140	−0.066	0.437
Subdural hemorrhage	140	−0.209*	0.013*
Brainstem hemorrhage contusion	140	−0.134	0.114
Subdural hematoma	140	−0.097	0.256
Cerebral edema	140	−0.091	0.285
Subgleal hematoma	140	0.217*	0.010**
Epidural hemorrhage	140	−0.054	0.528
Intracranial hemorrhage	140	−0.080	0.346
Tympanic membrane rapture	140	0.006	0.941
Intraventricular hemorrhage	140	0.199*	0.018*
Hemorrhagic contusion	140	0.011	0.901
Pneumocephaly	140	0.106	0.212

**Correlation is significant at the 0.01 level (two-tailed), *correlation is significant at the 0.05 level (two-tailed). GCS: Glasgow Coma Scale

Discussion

MFT is a frequent presentation of RTAs, ranging from simple nasal fractures to severe maxillofacial injuries, especially among the young adults. In the present study, young adults (aged 21–40 years) were the most common sufferers of MFT. Brain damage (59.1%) and shock (43.5%) requiring blood transfusions usually accompany the maxillofacial injuries. Fractures of parietal bones following temporal and frontal bones fractures mainly contributed to the brain damage. Similarly, fractures of maxillary sinus following the fractures of the orbital wall and nasal bone were primarily associated with brain damage. In the present study, brainstem hemorrhage contusion, epidural hemorrhage, and subarachnoid hemorrhage were the most common type of brain damage.

Most of RTAs and MFT are encountered among young and economically active individuals. In the present study, the most common patients with RTA and MFT were aged 21–30 years (43%) followed by the patients aged 31–40 years (23.6%). It indicates that young adults were the most common sufferers of RTIs and MFT. The reasons for high rate of RTIs among young people may include high speed, overconfidence, thrill-seeking, not obeying the traffic laws, aggressive personality traits, poor education, stress, and lack of proper attitude.[13] Mansuri *et al.* reviewed road safety and RTAs in KSA and reported that young drivers most commonly encounter RTIs due to their behavior, having fun on the roads, over-speeding, and overconfidence.[8] Similarly, Bokhari reviewed MFT due to RTAs in KSA, reporting most common incidence among most active and productive individuals (aged 21–49 years).[14] Hammoudi *et al.* reported more than 50% of total deaths among the age group between 18 and 35 years old in Emirates in 2010.[15] It indicates that age has a significant impact on the rate of RTAs and this finding is important in the context that age group requires more attention for the purpose of reduction in RTAs.

MFT and traumatic brain injuries (TBIs) are a significant concern globally. RTAs contribute significantly to TBIs, causing the majority of trauma deaths. The face is the most exposed part of the body and so is easily prone to trauma by RTAs. In the present study, 59.1% patients with MFT sustained brain damage. Rajandram *et al.* reported 36.7% TBIs among the patients with MFT presented at UKM Medical Center Malaysia.[16] It shows that brain injuries are more in KSA as compared to other countries. However, the present study is the unique study to report TBIs among the patients with MFT due to RTAs. Further studies are required to validate these results, as this is the only study available in this context.

Along with facial contusions and abrasions, lacerations are frequently encountered in the patients with maxillofacial injuries. Lacerations usually occur in severe trauma such as RTAs.[17] In the present study, MFT was associated with 38% scalp lacerations. The studies are related to injuries in 312 patients with MFT, including the reported most common lacerations of the forehead (37.3%), followed by scalp lacerations (13.9%).[18] The reason for this difference can be attributed to the increased incidence of head injury in the present study.

Patients with MFT and head injury may experience hypovolemic shock due to excessive bleeding or hemorrhage, requiring a blood transfusion. In the present study, 43.5% patients with MFT due to RTA underwent first to third-degree shock, requiring 1–5 points of blood. However, Bynoe *et al.* and Sakamoto *et al.* reported 1.2% and 25% incidence of shock in the patients with MFT, respectively.[19,20] The reason for this huge difference is the low rates of wearing seat belts in Saudi Arabia. In a study, seat belt wearing rate was measured only among 13.3% nonhealth-care providers.[21] In the present study, 97.5% patients with MFT were males. The reason for the low rate of MFT among females is that females were not allowed to drive except for the last 3 months of this study. Hence, the incidence of MFT was low among women in Saudi Arabia.

Brain damage is common in patients with maxillofacial injuries. In the present study, brain damage was noted in 59.1% patients with MFT. In this context, brainstem hemorrhage contusion, epidural hemorrhage, and subarachnoid hemorrhage were the most common brain injuries. Other types of brain damage included subdural hemorrhage, subgaleal hematoma, brain edema, and chemosis. Among these brain injuries, periorbital edema, subdural hemorrhage, subgaleal hematoma, and intraventricular hemorrhage had a significant effect on GCS of the patients. Eidt *et al.* and Davidoff *et al.* reported 35.7% and 55% cranioencephalic trauma (CET) in the patients with MFT, respectively.[22,23] In this context, data from KSA are lacking.

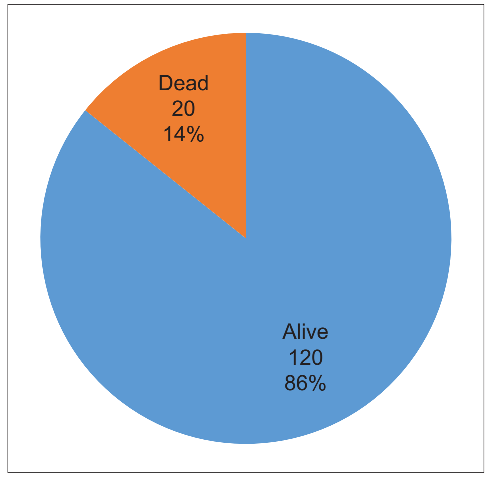

Figure 5: Mortality rate

Maxillofacial injuries are associated with high morbidity and mortality. In the present study, 14.3% patients who sustained MRI-proven brain damage died. It has been studied that failure to intubate and securing airway are the most common causes of death in maxillofacial injuries.[24]

Conclusion

In KSA, MFT is a frequent presentation of RTAs, ranging from simple nasal fractures to severe maxillofacial injuries, especially among the young adults. Maxillofacial injuries are associated with high morbidity and mortality. Therefore, it requires a sound evaluation of the risk factors for RTAs and establishment of guidelines to decrease the incidence of road traffic injuries and reduce health-care burden. Road safety campaigns focused on young population can help reduce RTAs and subsequent mortalities. Prompt arrival at the hospital, early diagnosis, and timely management of maxillofacial fractures and brain damages by skilled physicians will lower mortality rate in KSA.

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Conflicts of interest

There are no conflicts of interest.

References

1. Naeem Z. Road traffic injuries – Changing trend? Int J Health Sci (Qassim) 2010;4:v-viii.
2. Ansari S, Akhdar F, Mandoorah M, Moutaery K. Causes and

effects of road traffic accidents in Saudi Arabia. Public Health 2000;114:37-9.

3. Touahmia M. Identification of risk factors influencing road traffic accidents. Eng Technol Appl Sci Res 2018;8:2417-21. Available from: http://www.etasr.com/index.php/ETASR/article/view/1615. [Last accessed on 2018 Mar 22].
4. Jose A, Nagori SA, Agarwal B, Bhutia O, Roychoudhury A. Management of maxillofacial trauma in emergency: An update of challenges and controversies. J Emerg Trauma Shock 2016;9:73-80.
5. Mazen A. Maxillofacial fractures in Makka city in Saudi Arabia; an 8-year review of practice. Am J Public Health Res 2015;3:56-9.
6. Saad AH, Al Gadhi SA, Mufti RK, Malick DF. Estimating the total number of vehicles active on the road in Saudi Arabia. J King Abdul Aziz Univ Eng Sci 2002;14:3-28.
7. Al Turki YA. How can Saudi Arabia use the decade of action for road safety to catalyse road traffic injury prevention policy and interventions? Int J Inj Contr Saf Promot 2014;21:397-402.
8. Mansuri FA, Al-Zalabani AH, Zalat MM, Qabshawi RI. Road safety and road traffic accidents in Saudi Arabia. A systematic review of existing evidence. Saudi Med J 2015;36:418-24.
9. Ansary LA, Esmaeil SA, Adi YA. Causes of death certification of adults: An exploratory cross-sectional study at a university hospital in Riyadh, Saudi Arabia. Ann Saudi Med 2012;32:615-22.
10. Bokhari K. Pattern of Maxillofacial Injuries in Road Traffic Accidents: Review & Recommendations; 2015. Available from: https://www.researchgate.net/publication/291246892_Pattern_of_Maxillofacial_Injuries_in_Road_Traffic_Accidents_Review_Recommendations. [Last accessed on 2018 Mar 22].
11. Abdullah WA, Al-Mutairi K, Al-Ali Y, Al-Soghier A, Al-Shnwani A. Patterns and etiology of maxillofacial fractures in Riyadh city, Saudi Arabia. Saudi Dent J 2013;25:33-8.
12. Jan AM, Alsehaimy M, Al-Sebaei M, Jadu FM. A retrospective study of the epidemiology of maxillofacial trauma in Jeddah, Saudi Arabia. J Am Sci 2015;11:57-61.
13. Al-Naami MY, Arafah MA, Al-Ibrahim FS. Trauma care systems in Saudi Arabia: An agenda for action. Ann Saudi Med 2010;30:50-8.
14. Bokhari K. Maxillofacial injuries due to road traffic accidents in Saudi Arabia: A review of incidence, demographic factors and prevention strategies. Int J Med and Dent Sci 2017;6:1386-91.
15. Hammoudi A, Karani G, Littlewood J. Road traffic accidents among drivers in Abu Dhabi, United Arab Emirates. J Traffic Logist Eng 2014;2:7-12.
16. Rajandram RK, Syed Omar SN, Rashdi MF, Abdul Jabar MN. Maxillofacial injuries and traumatic brain injury – A pilot study. Dent Traumatol 2014;30:128-32.
17. Kapoor P, Kalra N. A retrospective analysis of maxillofacial injuries in patients reporting to a tertiary care hospital in East Delhi. Int J Crit Illn Inj Sci 2012;2:6-10.
18. Obuekwe ON, Etetafia M. Associated injuries in patients with maxillofacial trauma. Analysis of 312 consecutive cases due to road traffic accidents. J Med Biomed Res 2004;3:30-6.
19. Bynoe RP, Kerwin AJ, Parker HH 3rd, Nottingham JM, Bell RM, Yost MJ, *et al.* Maxillofacial injuries and life-threatening hemorrhage: Treatment with transcatheter arterial embolization. J Trauma 2003;55:74-9.
20. Jawadi AH, Alolayan LI, Alsumai TS, Aljawadi MH, Philip W, Alharthy NA, *et al.* Seat belt usage and distracted driving behaviors in Saudi Arabia: Health-care providers versus non health-care providers. J Musculoskelet Surg Res 2017;1:10-5.
21. Scherbaum Eidt JM, De Conto F, De Bortoli MM, Engelmann JL, Rocha FD. Associated injuries in patients with maxillofacial trauma at the hospital São Vicente de Paulo, Passo Fundo, Brazil. J Oral Maxillofac Res 2013;4:e1.
22. Davidoff G, Jakubowski M, Thomas D, Alpert M. The spectrum of closed-head injuries in facial trauma Victims: Incidence and impact. Ann Emerg Med 1988;17:6-9.
23. Samman M, Ahmed SW, Beshir H, Almohammadi T, Patil SR. Incidence and pattern of mandible fractures in the Madinah region: A retrospective study. J Nat Sci Biol Med 2018;9:59-64.
24. Gruen RL, Jurkovich GJ, McIntyre LK, Foy HM, Maier RV. Patterns of errors contributing to trauma mortality: Lessons learned from 2,594 deaths. Ann Surg 2006;244:371-80.