Study of the Pattern of Maxillofacial Fractures Seen at a Tertiary Care Hospital in North India

Sandeep Pandey · Ajoy Roychoudhury ·
Ongkila Bhutia · Maneesh Singhal ·
Sushma Sagar · Ravindra Mohan Pandey

Received: 16 May 2013 / Accepted: 23 August 2013 / Published online: 4 September 2013
© Association of Oral and Maxillofacial Surgeons of India 2013

Abstract

Aim The present study was planned to investigate the etiology of maxillofacial injuries and to analyze the pattern of maxillofacial fractures as well as the various factors influencing their distribution.

Study design A one year cross-sectional study was done and 1,108 patients with maxillofacial fractures were analyzed consecutively from April 2010 to March 2011 who reported to the department of Oral and Maxillofacial Surgery in the Centre for Dental Education & Research and Jai Prakash Narayan Apex Trauma Centre, AIIMS, New Delhi. A performa was designed to collect the data that included age and sex distribution, etiology, influence of alcohol, type of fractures, use of restraints devices, associated injuries and treatment delivered.

Results Out of 1,108 patients, 89.62 % were males with a male:female ratio of 8.63:1. The 21–30 year age group was found to be maximum (39.98 %). Road traffic accidents accounted for 49.01 %, followed by assault (22.38 %) and fall from height (21.66 %). Two wheelers were the most commonly involved vehicle. Out of 437 road traffic accident patients (excluding pedestrian, $n = 106$), only 52.40 % were found to be using restraints devices at the

time of accident. Totally 25.45 % patients were under the influence of alcohol at the time of injury. According to anatomical distribution of fractures, mandibular fractures (33.57 %) were most prevalent, followed by maxilla (31.13 %), nasal (28.33 %) and zygoma (24.36 %). Head injuries (18.32 %) were found to be the most common associated injuries followed by lower limb fractures.

Conclusion The motive behind executing this article is to analyze the various trends of facial fractures and all those factors that affect their distribution. A perfect understanding of pattern of maxillofacial fracture will assist the executors of health care in the treatment planning and management of facial injuries. Knowledge gained from the present study would influence in assessing the effectiveness of existing preventive measures and elaboration of future preventive measures and conducting new research.

Keywords Maxillofacial fracture · Road traffic accidents · Restraint devices · Head injuries

Introduction

Epidemiological survey changes with variation in the geographical region, socioeconomic strategy, cultural and surrounding factors. So these factors should be evaluated for comparison of the data and to know the differences in the distribution and happening of maxillofacial fractures across the world. Information obtained can be used as documentary evidence for formulating preventive measures taken for such injuries in future.

Trauma of the maxillofacial region is one of the most important health hazards across the world. Maxillofacial fractures lead to severe morbidity, cosmetic disfigurement as well as problems in oral functioning. The pattern of

S. Pandey · A. Roychoudhury · O. Bhutia (✉)
Department of Oral and Maxillofacial Surgery, All India
Institute of Medical Sciences, New Delhi 110029, India
e-mail: dr_ongkila@rediffmail.com

M. Singhal · S. Sagar
Department of Surgical Disciplines, All India Institute of
Medical Sciences, New Delhi 110029, India

R. M. Pandey
Department of Biostatistics, All India Institute of Medical
Sciences, New Delhi 110029, India

maxillofacial trauma in north India is not well understood. Observing maxillofacial trauma helps to assess the behavioral pattern of people in various regions worldwide and helps to provide effective means through which injuries can be prevented. There are variations in facial fractures due to differences in the severity and mode of injury. There are various reports on the incidence of maxillofacial fractures in different countries. It has been observed that in developing countries [1–7] facial fractures related to road traffic accident (RTA) account maximum incidence while in developed countries, most frequent mode is assault [8–11].

Materials and Methods

A 1 year cross-sectional study was conducted in the Department of Oral and Maxillofacial Surgery, Centre for Dental Education and Research and Jai Prakash Narayan Apex Trauma Centre, All India Institute of Medical Sciences, New Delhi from April 2010 to March 2011 after obtaining ethical clearance from the ethical committee of the Institute.

A proforma was prepared for the collection of data. Patients were evaluated by age, gender, mode of injury, history of alcohol intake, maxillofacial fracture sites and other associated injuries.

The modes of injury were classified as road traffic accident (RTA), assault, fall from height, occupational, sports, gunshot and others (animal attack, pathological fractures, explosive injury, etc.). Fractures were assessed according to location that is exclusively lower third, middle third and combination of both middle third and lower third. Sites of mandibular fractures were classified as symphysis, parasymphysis, body, angle, ramus, condyle, coronoid and dentoalveolar. Sites of mid-facial fractures were classified as maxilla, zygoma, naso-orbito-ethmoid, isolated zygomatic arch, orbital floor, nasal. The mid face fractures were also classified according to Lefort classification.

The data was entered into MS Office Excel 2007 and subjected to statistical analysis using STATA Version 11. The association between age, gender, mode of injury and site of fractures were assessed for statistical significance using Chi square test. The level of significance was fixed at 5 %.

Results

A total of 1,108 patients with maxillofacial fractures were studied. The patients age ranged from 2 to 85 years with mean age of 31.19 (SD $\pm$ 13.73). Of the sample, 89.62 % (n = 993) were males with a male to female ratio of 8.63:1 (Fig. 1).

Fig. 1 Gender wise distribution of the study subject (n = 1,108)

Age and Gender Wise Distribution

Overall, the 21–30 years age group was the most affected, comprising 39.98 % (n = 443) of patients. There was male dominance in all age groups (Table 1).

Mode of Injury in Relation to Gender

Table 2 reveals that the most common mode of injury in male was RTA (49.01 %), followed by assault (22.38 %), fall from height (21.66 %), sports, occupational, gunshot and others.

In females most common mode of injury was fall from height.

The most common vehicle involved was two wheeler (52.85 %) followed by four wheeler (15.10 %), bicycle (7.55 %) and three wheeler (3.68 %). In road traffic accidents, the highest of maxillofacial fractures were found among drivers (58.93 %) followed by passengers (20.25 %) and pedestrians (19.52 %).

The most common mechanism of injury in RTA patient was skid 21.36 % (n = 116), followed by hit from back by a four wheeler and head on collision with four wheeler. Out of 437 RTA patients (excluding pedestrians, n = 106), 52.40 % were using restraints or helmets. 25.45 % (n = 182) of patients were under the influence of alcohol at the time of injury.

Distribution of patients according to location of maxillofacial fractures is given in Table 3.

Middle third fracture was most commonly seen in the study.

According to anatomical site, mandible fractures were most prevalent 33.57 % (n = 372) followed closely by maxilla 31.13 % (n = 345), nasal 28.33 % (n = 314) and zygoma 24.36 % (n = 270) as presented in Fig. 2.

In the mandibular the most common was condylar fracture 42.47 % (n = 158). The second most common was parasymphysis 34.94 % (n = 130) followed closely by angle 34.13 % (n = 127). The least common sites were ramus 2.41 % (n = 9), coronoid 3.49 % (n = 13) and dento alveolar 5.37 % (n = 20) as shown in Fig. 3.

Table 1 Age and gender wise distribution of patients

Age group (years)	Male (n = 993)	Female (n = 115)	Total no. of subjects (n = 1,108)	Percentage (%)
0–10	25 (2.52 %)	18 (15.65 %)	43	3.88
11–20	157 (15.81 %)	17 (14.58 %)	174	15.70
21–30	412 (41.49 %)	31 (26.96 %)	443	39.98
31–40	204 (20.54 %)	22 (19.13 %)	226	20.40
41–50	109 (10.98 %)	14 (12.17 %)	123	11.10
>50	86 (8.66 %)	13 (11.30 %)	99	8.94
Total	993 (100 %)	115 (100 %)	1,108	(100 %)

$\chi^2 = 52.36$, P value <0.001, $df = 5$

Table 2 Distribution of patients according to mode of injury in relation to gender

Mode of injury	Male (n = 993)	Female (n = 115)	No. of patients
Road traffic accident	497 (50.05 %)	46 (40 %)	543 (49.01 %)
Assault	232 (23.36 %)	16 (13.91 %)	248 (22.38 %)
Fall from height	190 (19.13 %)	50 (43.48 %)	240 (21.66 %)
Sports	42 (4.23 %)	0	42 (3.29 %)
Occupational	11 (1.10 %)	1 (0.87 %)	12 (1.08 %)
Gunshot	10 (1.01 %)	0	10 (0.09 %)
Others	11 (1.10 %)	2 (1.73 %)	13 (1.17 %)
Total	993 (100 %)	115 (100 %)	1,108 (100 %)

$\chi^2 = 40.86$, P value <0.001, $df = 6$

Table 3 Distribution of patients according to location of maxillofacial fractures

Location	No. of patients	Percentage (n = 1,108)
Lower third	230	20.75
Middle third	736	66.42
Middle + lower third	142	12.81

Fig. 2 Distribution of patients according to anatomical fracture site

Mode of Injury and Mandibular Fracture Site

In case of RTA and fall from height, most common mandibular fracture site was condyle, while in assault it was angle.

Mode of Injury and Mid Face Fracture Site

Fig. 3 Distribution of patients according to mandibular fracture site

In RTA group most common mid face fracture site was maxilla (n = 239), whereas in case of assault and fall from height nasal bone (n = 121) was most commonly involved.

Age Group and Fracture In age group of 0–10 years, the most common fracture site was condyle while in age group 11–20 years, the incidence of condylar and angle fracture was almost similar but still condylar fractures were more in number. But in patients between 21 and 30 years of age, angle of the mandible was most commonly involved.

Table 4 Distribution of mid face fractures according to Lefort classification

Lefort classification	Unilateral	Bilateral	No. of patients	Percentage (n = 1,108)
Lefort I	138	34	172	15.52
Lefort II	88	35	123	11.10
Lefort III	52	20	72	6.49

Fig. 4 Associated injuries**Table 5** Treatment done

Treatment done	No. of patients	Percentage (n = 1,108)
Conservative	484	43.68
Closed reduction	148	13.35
Open reduction	171	15.43
Referred	257	23.91
Absconded	20	1.80
Died	28	2.52

Distribution of Mid Face Fracture at Lefort Level

Lefort I fractures were most prevalent 15.52 % (n = 172). Among unilateral fractures, the most common was Lefort I while in bilateral fractures Lefort II was the most common as presented in Table 4.

Figure 4 shows that among associated injuries, the majority of patients sustained head injuries 18.32 % (n = 203). Frontal bone fracture accounted for 9.11 % (n = 101). Lower limb fracture occurred in 4.51 % (n = 50), while upper limb fracture accounted for 3.70 % (n = 41).

Totally 484 patients (43.68 %) were treated conservatively, 148 (13.35 %) by closed reduction, 171 (15.43 %) by open reduction and internal fixation. 257 patients (23.91 %) were referred to other government hospitals due to various reasons (Table 5).

Discussion

In the present study, there was male prevalence with a male to female ratio of 8.63:1. Our finding correlates with that

from Uganda (7.7:1) [12], Switzerland (6.2:1) [13] and Nairobi (8.4:1) [14]. When compared with studies from United Arab Emirates (11:1) [15] and Nigeria (16.9:1) [16], this figure is relatively low but is considerably high when compared with studies from Korea (3.2:1) [9], Scotland (3:1) [17], Innsbruck (2.1:1) [18] and Finland (1.6:1) [19]. The higher percentage of males in this regard is related to the observation that in most of the families, males extensively work outdoors in order to earn the livelihood for the family which in turn makes them more susceptible to involve in RTA and assault.

Most commonly affected age group was 21–30 years in the present study as found in many other studies [12, 16, 20, 21]. This could be because people in this age group usually complete their education and venture out in search of jobs; are involved in more outdoor activity making them more vulnerable to injuries as compared to other age groups.

Road traffic accident is a major cause of maxillofacial injury in our study. Our finding correlates with the findings of other studies [1, 2, 4, 5, 12, 15, 22, 24, 25, 27, 28, 30, 31] in respect to RTAs being the main etiological factor for maxillofacial fractures. This could be due to the fact that there is lack of individual sensitization about importance of safety devices of the vehicle, lack of adherence to safety rules and regulation, (most of the vehicles do not have all the safety devices), lack of clear road traffic signal, congestion on the road due to lack of separate pathways for pedestrians, large numbers of overloaded buses and poorly maintained two wheelers.

Comparison of different modes of injury with other studies is given in Table 6.

We found that higher percentages of maxillofacial fractures in female were caused by fall from height (43.48 %). This is in accordance to study by Ellis et al. [17] and Rocca et al. [32]. This is due to the fact as reported by studies that females are not much associated with any kind of outdoor occupation and sports related injuries [1, 7, 18, 20, 33].

Two Wheeler as Most Common Vehicle

The vehicle most commonly involved in RTA in our study was the two wheeler as also reported in other studies [2, 3, 27, 28]. People using two wheelers for travelling are more prone to RTA than four wheeler users as two wheelers are

Table 6 Comparison of different modes of injury with other studies

Region	Total patients (n)	RTA (%)	Assault (%)	Fall from height (%)	Sports (%)	Year of publication	Related reference
Jeju, Korea	318	17	40.9	9.1	11.9	2010	Lee et al. [9]
Ugandan	132	56.06	34.84	–	3.79	2009	Adriane et al. [12]
Brazil	132	48.4	36.4	9.8	–	2009	Maliska et al. [22]
New Zealand	1,045	10	49	13	16	2008	Lee [23]
Southern Bulgaria	1,706	15.5	61	12.5	–	2007	Bakardjiev and Pechalova [20]
Piracicaba, Brazil	1,024	45	22.6	17.9	7.8	2006	Brasileiro and Passeri [24]
Northern Iran	7,200	91	2.9	5.5	0.6	2006	Kadkhodaie [4]
Lahore, Pakistan	702	54	8	19	0.5	2005	Cheema and Amin [5]
Sharjah, UAE	230	75	12	12	2.6	2004	Al Ahmed et al. [15]
Hamedan, Iran	2,268	60	10	18.9	1.05	2004	Ansari [1]
Diyrbakir, Turkey	2,901	38	10	36.7	1.1	2004	Erol et al. [25]
New Jersey, USA	92	18.5	75	–	–	2004	Laski et al. [11]
Ibadan, Nigeria	483	69.2	12	9.1	5.2	2003	Fasola et al. [2]
Northern Nigeria	306	36	48	9	4	2002	Olasoji et al. [26]
Netherland	1,324	50.5	13.4	12.4	15.3	1999	van Beek and Merckx [27]
Nigeria	442	71.9	8.4	10.9	3.2	1998	Ugboko et al. [28]
Michigan	788	13.5	70.1	9.3	–	1989	Scherer et al. [29]
Ibadan, Nigeria	104	80.7	8.65	1.92	1.92	1986	Abiose [30]
Scotland	2,137	15.1	54.7	21.3	3.5	1985	Ellis et al. [17]
Sweden	368	34.8	27.1	–	–	1980	Afzelius and Rosen [31]
Present study	1,108	49.01	22.38	21.66	3.29	2011	

relatively less stable and provide lesser protection to the riders, The most commonly involved mechanism of injury in current study was skid, followed by rear impact crashes.

Protective effect of restraints offer a significant reduction in facial fractures in road traffic accidents [34, 35]. Though legislation has made compulsory use of seatbelts and helmets in India, inspite of this the use of safety devices during driving is lacking, which is explained clearly by our figures in this study i.e. 47.6 % patients were not using the safety devices at the time of accident. This finding is in contrast to the study by Weninger and Hertz [36] which showed a higher percentage (84.1 %) and Gopalakrishna et al. [37] which presented a lower value (18.1 %) of the restraints use. General public should be sensitized regarding traffic rules and regulations, importance of safety devices and safe driving rules as well as the law has to be mandatory to all and its enforcement should be there in order to lower the incidence of RTA.

Alcohol consumption is also a contributing factor to the occurrence of maxillofacial injuries [38]. In the present study, 25.45 % of the patients were under the influence of alcohol at the time of injury which is similar to the study by Eggensperger et al. [13]. But this value is less as compared to the study by Gopalakrishna et al. [37] (41.4 %) and Shapiro et al. [39] (45 %) and more as compared to the study by Lee et al. [9] (18.8 %). This figure also indicates

that safe driving rules and regulations are not being implemented strictly.

Distribution of Maxillofacial Fractures According to Anatomical Third

In present study, the most common location of the maxillofacial fractures was found to be middle third (66.42 %). This finding correlates with the findings of other studies [13, 18, 27, 31, 40]. But in other studies isolated lower third fractures were found to be maximum [1, 7, 12, 19, 26, 30].

The facial bones act as an energy absorbing cushion and reduce the risk of traumatic brain injury, thus protecting the intracranial organs [41].

Mandible as Commonest Bone Involved

Mandible was the most commonly involved bone in the present study. Although being the heaviest and strongest facial bone, the mandible is more susceptible to fracture because it is the only movable facial bone and it has anatomical peculiarity in form and location. Various studies have also shown the mandible to be the most affected bone [1, 2, 7, 12, 15, 19, 22, 24, 26, 28, 33, 42]. But other studies accounted zygoma to be the maximally involved bone [29, 43].

Condylar Fracture in the Mandible as Commonest Fracture

We have seen that the condylar fracture was the most common fracture that occurred in the mandible. This finding correlates with findings of other studies [7, 15, 18, 19, 24, 27, 32, 33, 42].

However in contrast to our study, various studies have reported that most common mandibular fracture site was body of the mandible by [1, 17, 22, 26, 28, 30, 44, 45], parasymphysis [3, 6, 46], symphysis by [12] and angle of the mandible by [9].

Relation Between Mode of Injury and Mandibular Fracture Site

A report with high values of RTA tended to present predominantly condylar fracture in the study. Various studies have confirmed this finding [15, 17, 19, 27, 42]. Some studies accounted for fractures of the body to be the most frequent mandibular fracture sites [12, 17] while others showed symphysis [45] and parasymphysis [46] related to road traffic accident mode. A possible explanation for this finding i.e. condylar fracture as most common, is due to the fact that most of the commercially available helmets for two wheeler do not cover the total facial area especially the chin. Fall from two wheeler on chin causes indirect trauma to the condyles. It is a known fact that condylar fractures often result from an indirect trauma to the chin. This is the trauma mechanism for more number of condylar fractures seen in our study.

In case of trauma from assault, angle of the mandible was the common site for fracture which is in accordance to other studies [12, 17, 24, 40, 46]. This is because as the angle is a weak region due to thinner cross-section and presence of third molar, lateral impact forces enforced on angle region leads to its fracture.

Lefort I as Most Common Fracture in Mid Face Region

In the middle third region, most common site of fracture was maxilla. This finding correlates with findings of other studies [12, 15, 33]. Zygomatic complex as most common site was reported by some studied [1, 13, 19, 22, 24] and nasal bone fractures by others [7, 9].

Majority of middle third fractures were situated at the Lefort I level followed by Lefort II and Lefort III fractures [15, 24, 43]; similar results were seen in other studies as well.

Relation Between Mode of Injury and Mid Face Fracture Site

In RTA group most common mid face fracture site was maxilla which is in accordance to the study by Kamulegeya et al. [12].

In assault most prevalent mid face fracture location was nasal bone while in others it was zygomatic complex [12, 17, 29, 40]. The involvement of nasal bone is attributed to its prominent location on the face and relative structural weakness.

Fracture in Pediatric Patients

In pediatric patients, most common site of mandibular fracture was condyle. The understanding of the anatomy and development of growing pediatric mandible will enable to explain this phenomenon. The shape of the condyle which has a relatively broad neck and high content of cancellous bone with only thin rim of cortex makes it the weakest site in the mandible, so force transmitted here will results in fracture of the neck and subcondylar region [47].

Associated Fractures

In the present study, head injuries were the most common associated injuries followed by lower limb fractures. This finding correlates with that of other studies [36, 38].

We found that the overall mortality was 2.52 % (28 patients) out of which 92.85 % patients were males. The most common mode related to death was RTA (78.57 %) followed by fall from height mode (7.1 %). Out of the 28 patients who died, 53.57 % (15 patients) had associated frontal bone fracture and 14.28 % (4 patients) were associated with ribs fracture too. The cause of death in most patients was severe head injury.

Management of the Maxillofacial Fractures

Treatment of maxillofacial fractures varies from surgeon to surgeon and depends on available facilities. Most of the patients with nasal, zygomatic arch, and pediatric condylar fractures were treated conservatively.

Before rendering close or open method of treatment for maxillofacial injuries important consideration should be made regarding age of the patient, type of the fracture, involvement of neighboring vital structures and associated injuries.

The management of severe maxillofacial trauma is challenging and to optimize patient care and outcome, an interdisciplinary approach by different specialties is required.

Conclusion

Due to non adherence to traffic rules and regulations, lack of knowledge about the importance of restraint devices, lack of knowledge about safe driving, congestion of road

by more number of vehicles, lack of clear traffic signals and separate pedestrian roads in majority of the areas, all fulfill the criteria required for more number of road traffic accidents which is the most common cause of maxillofacial fracture in our study.

Remedy: There is need for sensitizing every individual (drivers, passengers, pedestrians, general public including children from the school level (provision to implement in school syllabus)) about the rules and regulations of traffic, safe driving and importance of using the restraints devices during driving.

References

1. Ansari MH (2004) Maxillofacial fractures in Hamedan province, Iran: a retrospective study (1987–2001). *J Craniomaxillofac Surg* 32(1):28–34
2. Fasola AO, Nyako EA, Obiechina AE, Arotiba JT (2003) Trends in the characteristics of maxillofacial fractures in Nigeria. *J Oral Maxillofac Surg* 61(10):1140–1143
3. Subhashraj K, Nandakumar N, Ravindran C (2007) Review of maxillofacial injuries in Chennai, India: a study of 2748 cases. *Br J Oral Maxillofac Surg* 45(8):637–639
4. Kadkhodaie MH (2006) Three-year review of facial fractures at a teaching hospital in northern Iran. *Br J Oral Maxillofac Surg* 44(3):229–231
5. Cheema SA, Amin F (2006) Incidence and causes of maxillofacial skeletal injuries at the Mayo Hospital in Lahore, Pakistan. *Br J Oral Maxillofac Surg* 44(3):232–234
6. Thapliyal GK, Sinha R, Menon PS, Chakranarayan A (2008) Management of mandibular fracture. *MJAFI* 64:218–220
7. Chandra Shekar BR, Reddy CVK (2008) A five-year retrospective statistical analysis of maxillofacial injuries in patients admitted and treated at two hospitals of Mysore City. *Indian J Dent Res* 19(4):304–308
8. Malara P, Malara B, Drugacz J (2006) Characteristics of maxillofacial injuries resulting in road traffic accidents—a 5 year review of the case records from Department of Maxillofacial Surgery in Katowice, Poland. *Head Face Med* 28(2):27
9. Lee JH, Cho BK, Park WJ (2010) A 4 year retrospective study of facial fractures in Jeju, Korea. *J Craniomaxillofac Surg* 38(3):192–196
10. Kieser J, Stephenson S, Liston PN, Tong DC, Langley JD (2002) Serious facial fractures in New Zealand from 1979 to 1998. *Int J Oral Maxillofac Surg* 31(2):206–209
11. Laski R, Ziccardi VB, Broder HL, Janal M (2004) Facial trauma: a recurrent disease? The potential role of disease prevention. *J Oral Maxillofac Surg* 62(6):685–688
12. Kamulegeya A, Lakor F, Kabenge K (2009) Oral maxillofacial fractures seen at a Ugandan tertiary hospital: a six-month prospective study. *Clinics* 64(9):843–848
13. Eggensperger N, Smolka K, Scheidegger B, Zimmermann H, Iizuka T (2007) A 3-year survey of related maxillofacial fractures in central Switzerland. *J Craniomaxillofac Surg* 35(3):161–167
14. Mwaniki DL, Guthua SW (1990) Occurrence and characteristics of mandibular fractures in Nairobi, Kenya. *Br J Oral Maxillofac Surg* 28(3):200–202
15. Al Ahmed HE, Jaber MA, Abu Fanas SH, Karas M (2004) The pattern of maxillofacial fractures in Sharjah, United Arab Emirates: a review of 230 cases. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 98(2):166–170
16. Adekeye EO (1980) The pattern of fractures of the facial skeleton in Kanduna, Nigeria. A survey of 1,447 cases. *Oral Surg Oral Med Oral Pathol* 49(6):491–495
17. Ellis E 3rd, Moos KF, El-Attar A (1985) Ten years of mandibular fractures: an analysis of 2,137 cases. *Oral Surg Oral Med Oral Pathol* 59(2):120–129
18. Gassner R, Tuli T, Hachl O, Rudisch A, Ulmer H (2003) Cranio-maxillofacial trauma: a 10 year review of 9543 cases with 21067 injuries. *J Craniomaxillofac Surg* 31(1):51–61
19. Thorén H, Iso-Kungas P, Iizuka T, Lindqvist C, Törnwall J (2009) Changing trends in causes and patterns of facial fractures in children. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 107(3):318–324
20. Bakardjiev A, Pechalova P (2007) Maxillofacial fractures in Southern Bulgaria: retrospective study of 1706 cases. *J Craniomaxillofac Surg* 35(3):147–150
21. Devadiga A, Prasad KSV (2008) Epidemiology of maxillofacial fractures and concomitant injuries in a craniofacial unit: a retrospective study. *Internet J Epidemiol* 5:2
22. Maliska MC, Lima Júnior SM, Gil JN (2009) Analysis of 185 maxillofacial fractures in the state of Santa Catarina, Brazil. *Braz Oral Res* 23(3):268–274
23. Lee KH (2008) Epidemiology of mandibular fractures in a tertiary trauma centre. *Emerg Med J* 25(9):565–568
24. Brasileiro BF, Passeri LA (2006) Epidemiological analysis of maxillofacial fractures in Brazil: a 5-year prospective study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 102(1):28–34
25. Erol B, Tanrikulu R, Görgün B (2004) Maxillofacial fractures. Analysis of demographic distribution and treatment in 2901 patients (25-year experience). *J Craniomaxillofac Surg* 32(5):308–313
26. Olasoji HO, Tahir A, Arotiba GT (2002) Changing picture of facial fractures in northern Nigeria. *Br J Oral Maxillofac Surg* 40(2):140–143
27. Van Beek GJ, Merckx CA (1999) Changes in the pattern of fractures of the maxillofacial skeleton. *Int J Oral Maxillofac Surg* 28(6):424–428
28. Ugboko VI, Odusanya SA, Fagade OO (1998) Maxillofacial fractures in a semi-urban Nigerian teaching hospital: a review of 442 cases. *Int J Oral Maxillofac Surg* 27(4):286–289
29. Scherer M, Sullivan WG, Smith DJ Jr, Phillips LG, Robson MC (1989) An analysis of 1,423 facial fractures in 788 patients at an urban trauma center. *J Trauma* 29(3):388–390
30. Abiose BO (1986) Maxillofacial skeleton injuries in the western states of Nigeria. *Br J Oral Maxillofac Surg* 24(1):31–39
31. Afzelius LE, Rosén C (1980) Facial fractures. A review of 368 cases. *Int J Oral Surg* 9(1):25–32
32. Rocca F, Bianchi F, Zavattero E, Tanteri G, Ramieri G (2010) Characteristics of maxillofacial trauma in females: a retrospective analysis of 367 patients. *J Craniomaxillofac Surg* 38(4):314–319
33. Hosein M, Motamedi K (2003) An assessment of maxillofacial fractures: a 5-year study of 237 patients. *J Oral Maxillofac Surg* 61(1):61–64
34. Fonseca AS, Goldenberg D, Alonso N, Bastos E, Stocchero G, Ferreira MC (2007) Seating position, seat belt wearing, and the consequences in facial fractures in car occupants. *Clinics* 62(3):289–294
35. Simoni P, Ostendorf R, Cox AJ (2003) Effect of air bags and restraining devices on the pattern of facial fractures in motor vehicle crashes. *Arch Facial Plast Surg* 5(1):113–115
36. Weninger P, Hertz H (2007) Factors influencing the injury pattern and injury severity after high speed motor vehicle accident—a retrospective study. *Resuscitation* 75(1):35–41
37. Gopalakrishna G, Peek-Asa C, Kraus JF (1998) Epidemiologic features of facial injuries among motorcyclists. *Ann Emerg Med* 32(4):425–430

38. Obuekwe ON, Ojo MA, Akpata O, Etetafia M (2003) Maxillofacial trauma due to road traffic accidents in Benin City, Nigeria: a Prospective study. *Ann Afr Med* 2(2):58–63
39. Shapiro AJ, Johnson RM, Miller SF, McCarthy MC (2001) Facial fractures in a level I trauma centre: the importance of protective devices and alcohol abuse. *Injury* 32(5):353–356
40. Lida S, Matsuya T (2002) Paediatric maxillofacial fractures: their aetiological characters and fracture patterns. *J Craniomaxillofac Surg* 30(4):237–241
41. Chan J, Putnam MA, Feustel PJ, Koltai P (2004) The age dependent relationship between facial fractures and skull fractures. *Int J Pediatr Otorhinolaryngol* 68(7):877–881
42. Lindqvist C, Sorsa S, Hyrkas T, Santavirta S (1986) Maxillofacial fractures sustained in bicycle accidents. *Int J Oral Maxillofac Surg* 15(1):12–18
43. Hachl O, Tuli T, Schwabegger A, Gassner R (2002) Maxillofacial trauma due to work-related accidents. *Int J Oral Maxillofac Surg* 31(1):90–93
44. Nair KB, Paul B (1986) Incidence and aetiology of fractures of the facio-maxillary skeleton in Trivandrum. *Br J Oral Maxillofac Surg* 24(1):40–43
45. Martini MZ, Takahashi A, de Oliveira Neto HG, De Carvalho JP Jr, Curcio R, Shinohara EH (2006) Epidemiology of mandibular fractures treated in a Brazilian level I trauma public hospital in the city of São Paulo, Brazil. *Braz Dent J* 17(3):243–248
46. King RE, Scianna JM, Petruzzelli GJ (2004) Mandible fracture patterns: a suburban trauma center experience. *Am J Otolaryngol* 25(5):301–307
47. Rahman RA, Ramli R, Rahman NA, Hussaini HM, Idrus SM, Hamid AL (2007) Maxillofacial trauma of pediatric patients in Malaysia: a retrospective study from 1999 to 2001 in three hospitals. *Int J Pediatr Otorhinolaryngol* 71(6):929–936