Pattern of maxillofacial fractures: A 5-year analysis of 8,818 patients

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BACKGROUND: This multicenter study assessed the demographics, prevalence, causes, types, treatment, and complications of maxillofacial (MF) fractures managed by MF surgeons nationwide.

METHODS: This 5-year retrospective descriptive analytical chart study evaluated 8,818 patients treated for MF fractures from 2007 to 2012 at 11 medical centers. Parameters, including age, sex, cause of injury, site of injury, type of injury, fracture patterns, treatment modalities, and complications, were evaluated from patient charts and radiographs. Collected data were analyzed via *t* test or χ^2 test using SPSS 20 (Chicago, IL). A p value of less than 0.05 was considered statistically significant. This retrospective chart study was exempt from institutional review board approval.

RESULTS: There were 7,369 male patients (83.6%), 1,376 female patients (15.7%), and 73 patients (0.8%) of unknown sex (aged 6 months to 112 years); 39.54% (3,457 patients) were in the 21-year to 30-year age group (mean, 28.18 years). We found 5,737 mandibular fractures (65.1%); mandible fracture was the most common ($p < 0.05$), followed by maxillary (1,641, 18.6%), zygomatic (3,240, 36.0%), orbital floor (743, 8.4%), naso-orbitoethmoidal (472, 5.4%), nasal (848, 9.6%), and frontal (344, 3.9%) fractures. Road traffic accidents were the most common cause. Posttreatment documented complications included remaining neurosensory disturbance of the inferior alveolar nerve (16.01%) and the infraorbital nerve (15.5%), remaining neuromotor disturbance of the facial nerve (2.3%), blurred vision (2.43%), diplopia (3.2%), limitation of eye movement (1.6%), exophthalmoses (1.88%), blindness (0.8%), as well as postoperative infection and chronic osteomyelitis (1.0%).

CONCLUSION: On the basis of our study, mandibular fractures, in males and resulting from road traffic accidents in the third decade of life, were significant findings. Although the prevalence of MF fractures, demographics, and causes vary from one country to another and awareness of these patterns can provide insight to prevention protocols, this study shows that, despite better law enforcement of traffic regulations, better roads, better automobiles, and the like, the pattern of MF fractures in Iran has not changed significantly during the past 10 years. (*J Trauma Acute Care Surg*. 2014;77: 630–634. Copyright © 2014 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: Epidemiologic study, level IV.

KEY WORDS: Maxillofacial injury; jaw fractures; complications.

Maxillofacial (MF) injuries constitute one of the major health problems worldwide. Although these injuries are common worldwide, their patterns vary in different societies. Specific interest is directed to the incidence and variety of these injuries.[1] MF fractures are often associated with substantial morbidity, deformity, loss of function, and high treatment cost.[2]

The causes of MF injuries have changed during the past three to four decades and continue to do so. MF fracture patterns are consistently influenced by geographic area, socioeconomic status, and period of investigation.[3–10] Because of the social, cultural, and environmental factors, both the incidence and the etiology of MF fractures vary from one country to another.[11] The main cause of facial injuries reported in the literature are from road traffic accidents (RTAs), followed by altercations or interpersonal violence.[10] Epidemiologic studies have shown that most of the fractures occur between the ages of 21 years to 30 years. Males are usually the most commonly injured.[12,13] Coordinated, periodic, and sequential collection of data concerning demographic patterns of MF injuries may assist health care officials assess address the causes and evaluate effectiveness of previously implemented preventive protocols. Consequently, an understanding of the etiology, severity, temporal distribution, and prevalence of MF trauma may dictate priorities to be implemented on the basis of the findings.[14] Since MF fracture parameters and patterns are subject to change with time and technology (safer cars, airbags, antilocking brakes, one-way roads, enforcement of seat belts, wearing of helmet, and regulation of speed limit, etc.), we sought to assess parameters relevant to MF fractures on a nationwide scale to evaluate significant changes, if any, within the past 10 years.

PATIENTS AND METHODS

A 5-year retrospective descriptive analytical chart study evaluated records of 8,818 patients treated for MF fractures from

Submitted: April 8, 2014, Revised: May 9, 2014, Accepted: May 9, 2014.

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DOI: 10.1097/TA.0000000000000369

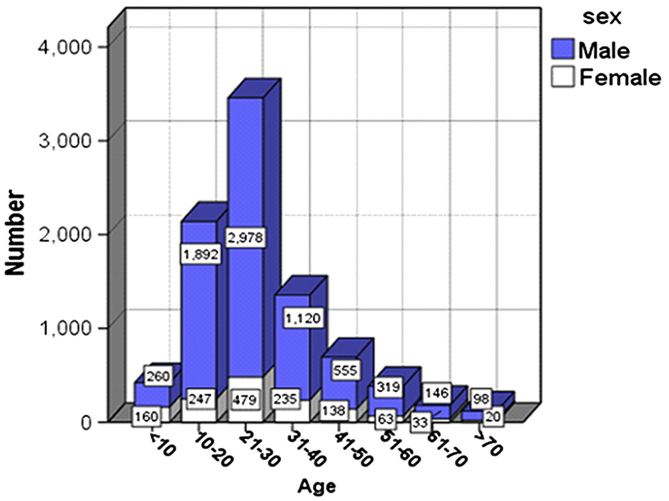

Figure 1. Distribution of patients based on age range and sex.

2007 to 2012 at 11 university medical centers (three in Tehran, one in Ahavaz, one in Shiraz, one in Isfahan, one in Mashhad, one in Kerman, one in Tabriz, one in Kashan, and one in Hamedan) in eight provinces of Iran. The parameters assessed included age, sex, cause of injury, site of injury, type of injury, fracture patterns, treatment modalities, and complications. The data were collected using a checklist and evaluated after completion. All MF injuries were assessed and treated by oral and MF surgeons. Concomitant bodily injuries were treated by appropriate consulted specialists.

Isolated nasal or frontal injuries were not referred for treatment by oral MF surgeons. Mean, SD, frequency, and distribution of data were evaluated and analyzed via *t* test and χ^2 test using SPSS 20. A *p* value of less than 0.05 was considered statistically significant. This retrospective chart study was exempt from institutional review board approval.

RESULTS

There were 7,369 male patients (83.6%), 1,376 female patients (15.7%), and 73 patients (0.8%) of unknown sex. The

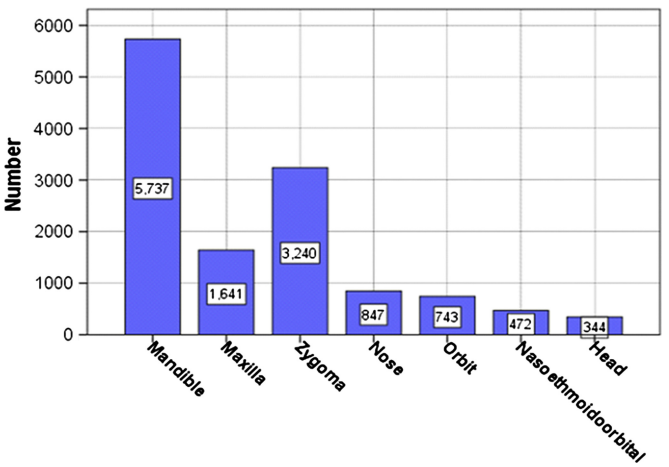

Figure 2. Distribution of 13,024 MF fractures.

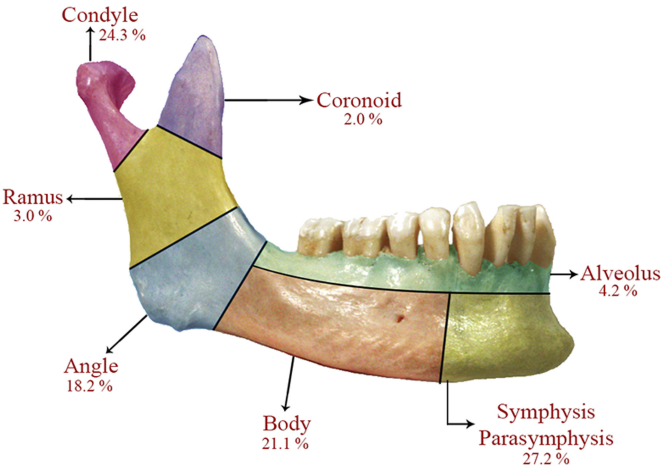

Figure 3. Distribution of mandibular fractures in regard to area.

patients ranged in age from 6 months to 112 years, with 39.54% (3,457 patients) in the 21-year to 30-year age group (Fig. 1).

Fracture Sites

There were 5,737 (65.1%) mandibular fractures ($p < 0.05$) as well as 1,641 maxillary (18.6%), 3,240 zygomatic complex (36.0%), 743 orbital floor (8.4%), 472 naso-orbitoethmoidal (5.4%), 848 nasal (9.6%), and 344 frontal (3.9%) injuries (Fig. 2). Distribution of mandibular fractures showed that 27.2% were in the symphyseal-parasymphyseal region, 24.3% were in the condylar region, 21.1% were in the body region, 18.2% were in the angle, 4.2% were in the alveolar region, 3.0% were in the ramus region, and 2.0% were in the coronoid region (Fig. 3). The distribution of maxillary fractures revealed Le Fort I in 723 (32.7%), Le Fort II in 701 (31.8%), Le Fort III in 164 (7.4%), hemi Le Fort I in 91 (4.1%), hemi Le Fort II in 30 (1.4%), hemi Le Fort III in 17 (0.7%), and alveolar fracture in 484 (21.9%, Fig. 4). The distribution of zygomatic fractures revealed 3,016 (92.2%) involving the

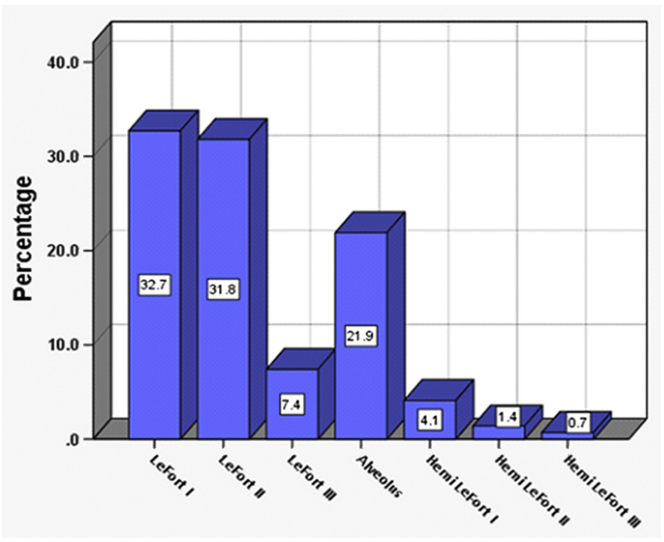

Figure 4. Distribution of maxillary fractures.

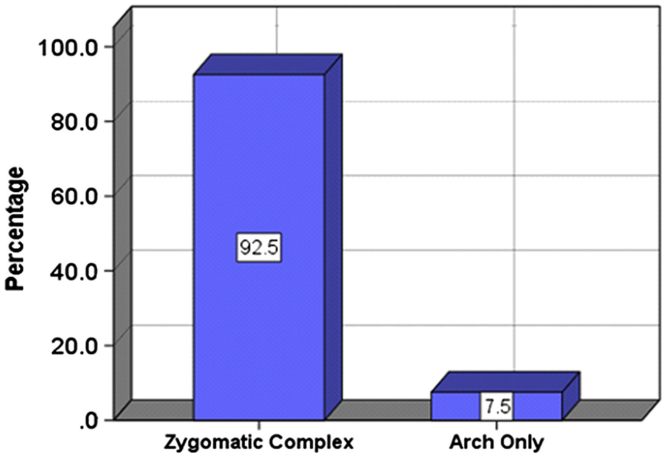

Figure 5. Comparison of zygomatic compex and isolated zygoma arch fractures.

zygomatic complex and 242 (7.5%) involving only the zygomatic arch (Fig. 5).

Causes

RTAs were the cause of the majority of fractures, 5,579 (63.81%) ($p < 0.05$), followed by falls, 1,226 (14.02%); altercations, 769 (8.72%); sports, 198 (2.2%); occupational injuries, 187 (2.1%); and warfare, 51 (0.57%, Fig. 6).

Treatment

Of the 5,737 mandibular fractures, 62.7% were treated by open reduction ($p < 0.05$); 31.3%, by closed reduction; and 5.8%, by observation only. Of 1,641 maxillary fractures, 27.4% were treated using closed reduction; 63.4%, using open reduction ($p < 0.05$); and 9.1%, with observation only. Of the 3,016 zygomatic complex fractures, 73.4% were treated using open reduction ($p < 0.05$); 12.8%, using closed reduction; and 14.2%, with observation only.

Complications

Trauma-related and remaining complications were recorded. They included damage of the sensory nerves, which was the most common complication associated with fractures ($p < 0.05$). These were mostly remaining neurosensory disturbances of the inferior alveolar nerve (16.01%) and the infraorbital nerve (15.5%), neuromotor disturbance of the facial nerve (2.3%), olfactory disturbance (0.15%), blurred vision (2.43%), diplopia (3.2%), limitation of eye movement (1.6%), exophthalmoses (1.88%), blindness (0.8%), as well as postoperative infection and chronic osteomyelitis (1.0%, SDC 1, http://links.lww.com/TA/A476).

DISCUSSION

Demographic data of MF fractures in this study showed that they were significantly more prevalent in men in the third decade of life. These results were similar when compared with data of several studies in various regions of the world.[2,5,6,15–21] The cultural and socioeconomic characteristics of the studied population may influence the rates of facial fractures in women.[22–24] The most affected age group was 21 years to 30 years (39.54%), followed by patients ranging from 11 years to 20 years. Many reports of MF fracture studies have similar results regarding age.[2,5,7,8,18,21,22,24–26] The possible reason was that males between the ages of 21 years and 30 years are more susceptible to traffic accidents and interpersonal violence because of their higher rate of commuting, consequently leading to higher rates of accidents and thus MF fractures.[3,23,25,27]

Distribution

In this study, the most frequent site involved in the MF region was the mandible (65.1%). Several previous studies correlate with our findings.[2,6,7,19,24,25,28] Studies with high rates of traffic accidents state lower jaw fractures to be the most frequent fracture, with predominance of the condylar segment,[6,20,23,26] but in our study, the most frequent fracture sites were the symphysis-parasymphysis and then the condyle region. Mandibular fractures in the body and angle region were predominant in studies with high interpersonal violence and the most prevalent fracture site being the zygomatic complex.[3,5,27,29–31]

Treatment

Innovations, technology, and materials have influenced MF trauma management in current years.[8,32] Thus, more surgeons are using open reduction and plate osteosynthesis instead of closed reduction, leading to early recovery, segment stability, more rapid return of function, and patient comfort.[33–35] Although treatment of facial fractures varies from surgeon to surgeon, it also depends on available instrumentation at hand. In our study, the main procedure for MF fracture treatment was open reduction in both jaws. This was similar to some surveys[36–38] and contradictory to some older studies.[6,39]

Prevention of MF Fractures

MF fractures caused by RTAs were significantly more common in this study than from other causes. This issue was noted in another smaller 5-year study (237 patients) done by the senior author (M.H.K.M.) in 2003; in that study, 89% were male patients, with 59.0% in the 20-year to 29-year age group, 72.9% had mandibular fractures, and 54% of all fractures were

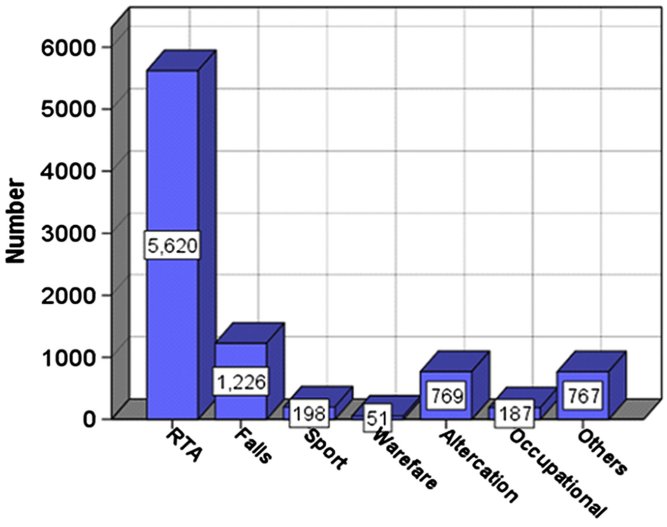

Figure 6. Distribution of causes of MF fractures.

caused by RTAs.[39] Thus, to prevent MF fractures, it seems prudent to prevent RTAs. Most RTAs are predictable and can be prevented. Interventions proven to be effective and merit mention have included lowering the speed limit, enforcing seat belts, and wearing a helmet with a chin guard to protect the mandible (the most commonly fractured bone associated with RTAs) while cycling.[40]

Use of traffic cameras, radars, cars with airbags, improving road design (one-way roads instead of two-way roads [to prevent head-on collisions]), separating different types of traffic, providing safer routes for pedestrians and cyclists, building skywalks or underground crossing structures for pedestrians, as well as use of speed bumps are among the measures taken to decrease MF injuries from RTAs in developing countries such as ours.[40]

Our study shows, however, that despite better law enforcement of traffic regulations and implementation of by laws, safer roads, contemporary automobiles, and the like, the pattern of MF fractures has not changed significantly in Iran, and RTAs remain to be the main cause of MF fractures (and have actually increased by 10% when compared with a former study done by the senior author in 2003, albeit on a smaller scale). However, the increase in the population, the increase in the number of automobiles, and the resultant increase in traffic were not taken into account; investigation of these issues in other nations for comparison of data and outcomes may be found beneficial in decreasing RTAs and MF fractures.

CONCLUSION

On the basis of the results of this study, MF fractures were significantly more common in males, in the third decade of life, in the body of the mandible, caused by RTAs and treated via open reduction. Damage of the sensory nerves was the most common remaining sequel associated with MF fractures ($p < 0.05$).

AUTHORSHIP

M.H.K.M. contributed to study design, draft writing, supervision, and revision. E.D. contributed to provincial data collection, draft writing, and analysis. A.E. contributed to supervision and assistance. G.S. contributed to data collection assistance in Tehran. A.H. contributed to data collection assistance in Isfahan. M.R.J. contributed to data collection assistance in Hamedan.

DISCLOSURE

The authors declare no conflicts of interest.

REFERENCES

1. Schaftenaar E, Bastiaens GJ, Simon EN, Merkx MA. Presentation and management of maxillofacial trauma in Dar es Salaam, Tanzania. *East Afr Med J*. 2009;86(6):254–258.
2. Kieser J, Stephenson S, Liston PN, Tong DC, Langley JD. Serious facial fractures in New Zealand from 1979 to 1998. *Int J Oral Maxillofac Surg*. 2002;31:206–209.
3. Ellis E III, El-Attar A, Moos KF. An analysis of 2,067 cases of zygomatic-orbital fractures. *J Oral Maxillofac Surg*. 1985;43:417–428.
4. Iida S, Matsuya T. Pediatric maxillofacial fractures: their etiological characters and fracture patterns. *J Craniomaxillofac Surg*. 2002;30:237–241.
5. Torgersen S, Tornes K. Maxillofacial fractures in a Norwegian district. *Int J Oral Maxillofac Surg*. 1992;21:335–338.
6. Ansari MH. Maxillofacial fractures in Hamedan province, Iran: a retrospective study (1987–2001). *J Craniomaxillofac Surg*. 2004;32:28–34.
7. Ahmed HEA, Jaber MA, Fanas SHA, Karas M. The pattern of maxillofacial fractures in Sharjah, United Arab Emirates: a review of 230 cases. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2004;98:166–170.
8. Hächl O, Tuli T, Schwabegger A, Gassner R. Maxillofacial trauma due to work-related accidents. *Int J Oral Maxillofac Surg*. 2002;31:90–93.
9. Bamjee Y, Lownie JF, Cleaton-Jones PE, Lownie MA. Maxillofacial injuries in a group of South Africans under 18 years of age. *Br J Oral Maxillofac Surg*. 1996;34:298–302.
10. Gassner R, Tuli T, Hachl O, Rudisch A, Ulmer H. Cranio-maxillofacial trauma: a 10 year review of 9543 cases with 21067 injuries. *J Craniomaxillofac Surg*. 2003;31:51–61.
11. Hagan EH, Huelke DE. An analysis of 319 case reports of mandibular fractures. *J Oral Surg*. 1961;19:93.
12. Shah A, Shah AA, Salam A. Maxillofacial fractures: analysis of demographic distribution in 230 patients. *Pak Oral Dent J*. 2006;26:235–238.
13. Bataineh AB. Etiology and incidence of maxillofacial fractures in north of Jordan. *J Oral Surg Oral Med Oral Pathol*. 1998;86:31–35.
14. Kubilius R, Keizeris T. Epidemiology of mandibular fractures treated at Kaunas University of Medicine Hospital, Lithuania. *Stomatologija*. 2009;11(3):73–76.
15. Down KE, Boot DA, Gorman DF. Maxillofacial and associated injuries in severely traumatized patients: implications of a regional survey. *Int J Oral Maxillofac Surg*. 1995;24:409–412.
16. Qudah MA, Bataineh AB. A retrospective study of selected oral and maxillofacial fractures in a group of Jordanian children. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2002;94:310–314.
17. Karyouti SM. Maxillofacial injuries at Jordan University Hospital. *Int J Oral Maxillofac Surg*. 1987;16:262–265.
18. Afzelius L, Rosén C. Facial fractures. *Int J Oral Surg*. 1980;9:25–32.
19. Laski R, Ziccardi VB, Broder H, Janal M. Facial trauma: a recurrent disease? The potential role of disease prevention. *J Oral Maxillofac Surg*. 2004;62:685–688.
20. Iida S, Kogo M, Sugiura T, Mima T, Matsuya T. Retrospective analysis of 1502 patients with facial fractures. *Int J Oral Maxillofac Surg*. 2001;30:286–290.
21. Fridrich KL, Pena-Velasco G, Olson RAJ. Changing trends with mandibular fractures. *J Oral Maxillofac Surg*. 1992;50:586–589.
22. Thorn JJ, Mogeltoft M, Hansen PK. Incidence and aetiological pattern of jaw fractures in Greenland. *Int J Oral Maxillofac Surg*. 1986;15:372–379.
23. Lindqvist C, Sorsa S, Hyrkas T, Santavirta S. Maxillofacial fractures sustained in bicycle accidents. *Int J Oral Maxillofacial Surg*. 1986;15:12–18.
24. Koorey AJ, Marshall SW, Treasure ET, Langley JD. Incidence of facial fractures resulting in hospitalization in New Zealand from 1979 to 1988. *Int J Oral Maxillofac Surg*. 1992;21:77–79.
25. Oji C. Jaw fractures in Enugu, Nigeria, 1985-95. *Br J Oral Maxillofac Surg*. 1999;37:106–109.
26. Van Beek GJ, Merkx CA. Changes in the pattern of fractures of the maxillofacial skeleton. *Int J Oral Maxillofac Surg*. 1999;28:424–428.
27. Adebayo ET, Ajike OS, Adekeye EO. Analysis of the pattern of maxillofacial fractures in Kaduna, Nigeria. *Br J Oral Maxillofac Surg*. 2003;41:396–400.
28. Fasola AO, Nyako EA, Obiechina AE, Arotiba JT. Trends in the characteristics of maxillofacial fractures in Nigeria. *J Oral Maxillofacial Surg*. 2003;61:1140–1143.
29. Iida S, Hassfeld S, Reuther T, Schweigert H, Haag C, Klein J, et al. Maxillofacial fractures resulting from falls. *J Craniomaxillofac Surg*. 2003;31:278–283.
30. Haug RH, Prather J, Indresano T. An epidemiologic survey of facial fractures and concomitant injuries. *J Oral Maxillofac Surg*. 1990;48:926–932.
31. Brook IM, Wood N. Etiology and incidence of facial fractures in adults. *Int J Oral Surg*. 1983;12:293–298.
32. Laskin DM, Best AM. Current trends in the treatment of maxillofacial injuries in the United States. *J Oral Maxillofac Surg*. 2000;58:207–215.
33. de Melo WM, Antunes AA, Sonoda CK, Hochuli-Vieira E, Gabrielli MA, Gabrielli MF. Mandibular angle fracture treated with new three-dimensional grid miniplate. *J Craniofac Surg*. 2012;23:e416–e417.
34. Fonseca RJ, Walker RV. *Oral and Maxillofacial Trauma*. 2nd ed. Philadelphia, PA: WB Saunders Company; 1997.

35. Prein J. *Manual of Internal Fixation in the Cranio-Facial Skeleton*. Berlin, Germany: Springer-Verlag; 1998.
36. Brasiliero BF, Passeri LA. Epidemiological analysis of maxillofacial fractures in Brazil: A 5-year prospective study. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2006;102:28–34.
37. Venugopal MG, Sinha R, Menon PS, Chattopadhyay PK. Fractures in the maxillofacial region: a four year retrospective study. *MJAFI*. 2010;66:14–17.
38. Rana ZA, Khoso NA, Arshad O, Siddiqi KA. An assessment of maxillofacial injuries: a 5-year study of 2112 patients. *Ann Pak Inst Med Sci*. 2010;6(2):113–115.
39. Motamedi MHK. An Assessment of maxillofacial fractures: a 5-year study of 237 patients. *J Oral Maxillofac Surg*. 2003;61:61–64.
40. UNICEF. Road traffic injuries in Iran and their prevention, a worrying picture. Available at: http://www.unicef.org/iran/media_4783.html/. Accessed May 9, 2014.