Epidemiological analysis of maxillofacial fractures in Brazil: A 5-year prospective study

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Objective. The aim of this study was to assess the characteristics of maxillofacial fractures in the Piracicaba region of Brazil during a 5-year period and to delineate comparisons with worldwide facial fracture patterns.
Study design. A descriptive statistical analysis was developed based on data collected using a specifically designed clinical survey of all patients who attended the Division of Oral and Maxillofacial Surgery at the Piracicaba Dental School from 1999 to 2004. Information regarding age, gender, etiology, and type of maxillofacial injury and its associated lesions were evaluated. In addition, treatment modalities and complication rates during patient follow-up were assessed.
Results. A total of 1024 patients presenting 1399 maxillofacial fractures were analyzed. Patients' ages ranged from 0 to 88 years (mean age, 28 ± 16.4 years). The ratio of men to women was 4:1. Most fractures were caused by traffic accidents (45%), followed by assaults (22.6%), falls (17.9%), sports accidents (7.8%), and work accidents (4.5%). The prevalent anatomic regions of facial fractures (in percentages) were the mandible (44.2%), the zygomatic complex (32.5%), and the nasal bones (16.2%). Associated systemic lesions were found in 41.9% of patients, with prevalence for injuries to the upper (24.1%) and lower limbs (15.4%). Patient management was considered to be conservative in 490 patients (47.9%), and surgical therapy was performed in 493 patients (48.1%), of whom 399 (80.9%) were treated with open reduction and rigid internal fixation. Complications occurred in 76 patients (7.4%), mainly due to infection and malocclusion.
Conclusion. The findings of this study indicated that epidemiological research of maxillofacial fractures allows the presentation patterns of the most affected individuals and the nature of their lesions to be outlined according to the region evaluated. Furthermore, treatment evaluation and complication rate analysis permits a more realistic interpretation of how patients should be managed.
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Injuries of the maxillofacial complex represent one of the most important health problems worldwide. Particular interest is created by the high incidence and diversity of facial lesions.[1-3] Moreover, maxillofacial fractures are often associated with severe morbidity, loss of function, disfigurement, and significant financial cost.[3-5]

The patterns of maxillofacial fracture presentation are consistently influenced by geographic area, socioeconomic status of the cohort, and the period of investigation.[6-12] According to reports of developing nations, traffic accidents are the main cause of maxillofacial fractures,[9,13-16] while data from developed countries pointed to assaults being considered the most frequent etiology of such fractures.[17-21] With regard to the anatomical sites, mandibular and zygomatic complex fractures account for the majority of all facial fractures and their occurrence varies according to the mechanism of injury and demographic factors, particularly, gender and age.[22-24] The coordinated and sequential collection of information concerning demographic patterns of maxillofacial injuries may assist health care providers to record detailed and regular data of facial trauma. Consequently, an understanding of the cause, severity, and temporal distribution of maxillofacial trauma permits clinical and research priorities to be established for effective treatment and prevention of those injuries.[25,26]

Since the adaptation by Champy et al.[27] in 1978 of Michelet et al's technique,[28] surgeons have increasingly used rigid internal devices to treat many maxillofacial fractures because of the favorable results achieved.[29,30] The appropriate use of plates, miniplates, and screws in such cases can be of great benefit as they can maintain the position of the reduced bone segments and do so without the need for intermaxillary fixation.[31,32]

Several studies have been conducted to investigate the epidemiological features of maxillofacial fractures in different population groups, such as Austria,[11,25,26] England,[3] Germany,[18] Greenland,[22] Finland,[23] Iran,[9] Italy,[33] Japan,[7,20] Jordan,[4,15] New Zealand,[2,5] Netherlands,[34] Nigeria,[13,14,16] Norway,[8] Scotland,[6,24] South Africa,[12] Sweden,[17] United Arab Emirates,[10] and the United States.[1,19,21] However, few specific facial

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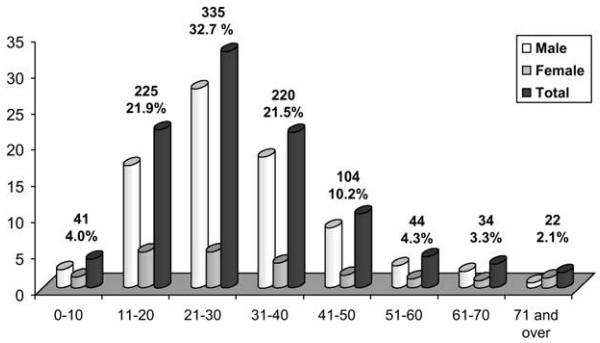

Fig. 1. Age distribution of 1024 patients with maxillofacial fractures.

fracture epidemiology reports on any South American country are found in the international literature,[35] and no prospective study has ever been published about general maxillofacial complex fracture analysis for this region. The following study was developed to evaluate the epidemiological characteristics of prevalence, treatment modalities, and complication rates of maxillofacial fractures in the Piracicaba region, Brazil, from 1999 to 2004. Comparison of results with similar studies in other regions of the world is also discussed.

MATERIAL AND METHODS

This was an observational, prospective, longitudinal study of patients presenting with maxillofacial fractures, attending the Division of Oral and Maxillofacial Surgery of Piracicaba Dental School, State University of Campinas, over a 5-year period (from 1 April 1999 to 31 March 2004). Participation in the study required the patient's consent in accordance with the recommendations of the National Health Committee – Brazilian Health Department and was approved by the Research Ethics Committee of this Institution. Each patient underwent a clinical examination using a standardized data collection form that was specifically developed to investigate the epidemiological features of maxillofacial trauma. Patients were evaluated, whether admitted to the hospital or treated as outpatients at 7 Level I Trauma Centers and the Oral and Maxillofacial Ambulatory of Piracicaba Dental School in the Piracicaba region, São Paulo State, Brazil.

Data regarding patient age, gender, socioeconomic activity, etiology, nature and type of injury, and concurrent corporeal lesions were catalogued. Maxillofacial fractures were distributed according to their etiological factors in traffic accidents (automobile, motorcycle, bicycle, and pedestrian motor vehicle accidents), assaults, falls, sports, work-related accidents, and others. Protective devices assessment was based on use of seatbelts, helmets, and glasses according to the etiology. The fractures were classified as mandibular fractures, zygomatic complex fractures (including isolated orbital fractures), maxillary fractures, isolated nasal bone fractures, frontal fractures, and nasal-orbital-ethmoid complex fractures.[36]

Investigation also included treatments, follow-up results, and trauma-associated complications. Patient management was divided into conservative (without reduction or fixation of skeletal fractures), surgical (requiring at least 1 intervention for reduction and/or fixation of the facial fractures), and untreated (comprising patients who had refused treatment, had been referred to other facilities, or died before treatment). The surgical interventions used were closed reduction (with arch bars, eye loops, and intermaxillary fixation) or open reduction and fixation of bone segments with wiring technique or internal rigid fixation with plates, miniplates, and screws, as appropriate.[36] Complications studied included infection, malocclusion, nonunion, bone deformities, functional deficits (mandibular motion, ocular motility, visual acuity, and nasal obstruction), and hardware removal.[37] For the records, each patient would not be dismissed from follow-up if any sign of edema, hematoma, or abnormality was diagnosed. Besides, patients' data could present more than one type of complication.

Patients who had refused to participate in the research or who had inadequately completed the form were excluded. Patients with isolated dental trauma (injuries to teeth and alveoli), either associated with soft tissue lesions or not, were not included. Data were presented by descriptive statistical analysis.

Table I. Occupation distribution of 1024 patients with maxillofacial fractures

	No. patients (%)		
Occupation	*Men*	*Women*	*Total*
Economically active	553 (67.6)	67 (32.5)	620 (60.5)
Not economically active			
Student	122 (14.9)	51 (24.8)	173 (16.9)
Unemployed	99 (12.1)	16 (7.8)	115 (11.2)
Dependent	44 (5.4)	72 (34.9)	116 (11.4)
Subtotal	265 (32.4)	139 (67.5)	404 (39.5)

RESULTS

During the 5 years of study, 1892 patients were attended for maxillofacial injuries. A total of 1024 of them were patients with facial fracture (818 men and 206 women, ratio 4:1) presenting 1399 fractures. Patients' age distribution is depicted in Fig. 1. The mean age was 30.6 ± 14.7 years, ranging from 2 to 88 years, while the average was 30.2 years for men and 32.2 years for women. According to the investigation about social activity (Table I), 60.5% of patients had

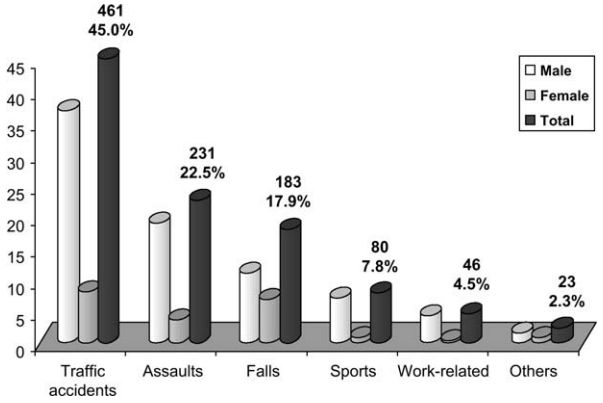

Fig. 2. Causes of injuries of 1024 patients with maxillofacial fractures.

Table II. Type of traffic accidents in patients with maxillofacial fractures

Type of traffic accident	*Number of patients*	*% of traffic accidents*
Bicycle accident	155	33.6
Automobile accident	143	31.0
Motorcycle accident	124	26.9
Pedestrian MVA	39	8.5
TOTAL	461	100.0

MVA, Motor vehicle accident.

Table III. Sites of maxillofacial fractures

Site	*No. patients (%)*
Lower third	
Mandible	423 (41.3)
Condyle	162 (15.8)
Symphysis	139 (13.8)
Body	133 (13.0)
Angle	113 (11.0)
Ramus	13 (1.3)
Coronoid	2 (0.2)
Middle third	
Zygomatic complex	398 (38.9)
Zygomatic body	319 (31.2)
Zygomatic arch	38 (3.7)
Zygomatic body + arch	41 (4.0)
Nasal bone	227 (22.2)
Maxilla	61 (6.0)
Le Fort I	23 (2.2)
Le Fort II	14 (1.4)
Le Fort III	6 (0.6)
Sagittal	10 (0.9)
Other	10 (0.9)
NOE	11 (1.1)
Upper Third	
Frontal	25 (2.4)
Total	1024 (100.0)

NOE, Nasal-orbital-ethmoid complex.

some professional occupation (67.6% for men and 32.5% for women), and 16.9% of the others were students.

The causes of injuries are listed in Fig. 2. Traffic accident was the most frequent etiological factor of maxillofacial fractures irrespective of gender (46.2% for men and 40.3% form women). Whereas the second most frequent cause of injuries for men was assault (23.9%); in women, traffic accidents were followed by falls (34%). The other etiologies maintained a similar hierarchy. Specific information concerning traffic accidents is shown in Table II, which demonstrated that bicycle accidents (33.6%) were the main cause of this specific injury type. However, particularly for women, the most observed type of traffic accident was automobile accident (44.6%). This injury type for men (28.0% of traffic accidents were automobile accidents) only ranked in third position of prevalence, after bicycle (34.1%) and motorcycle accidents (29.1%).

In these patients, 1399 fractures were diagnosed, with a prevalence of mandibular fractures (618, 44.2%) in 423 patients (ratio, 1.46 fractures per patient), and the second most frequent fracture type was found in the zygomatic complex (455, 32.5%), accounting for 398 patients. The fracture sites are presented in Table III. Specific analysis of fracture etiology and sites revealed different prevalence patterns. In traffic accidents the most frequent types of fractures were mandibular (49.7%) and zygomatic fractures (40.6%). The most frequent types of fractures in falls were also mandibular and zygomatic (51.4% and 38.8%, respectively). Assaults and work-related accidents were mainly responsible for zygomatic complex (35.1% and 50%) and mandibular (25.5% and 36.9%) fractures, respectively. There was an even higher discrepancy of results in sports accidents, since nasal bone (38.8%) and zygomatic complex fractures (37.5%) were the commonest lesions.

Data with regard to associated injuries in patients with maxillofacial fractures demonstrated that 58.5% of patients had some facial soft tissue lesion. Lacerations (36.6%) and abrasions (35.4%) were commonly diagnosed, while hematomas were seen less frequently (22.8%). One or other type of concurrent corporeal injury was also found in 41.9% of cases. Anatomical distribution of concurrent lesions is detailed in Fig. 3.

There were 462 patients (45.1%) who were treated as outpatients. Inpatients corresponded to 562 cases (54.9%), with a mean period of hospitalization of 4.4 days for men and 4.6 days for women (ratio of men:-women of 5.5:1). Patients considered as “untreated” accounted for 41 cases, including refusal of treatment (73.2%), death (17.1%), and institution transfers (9.7%). Conservative therapy was conducted in 490

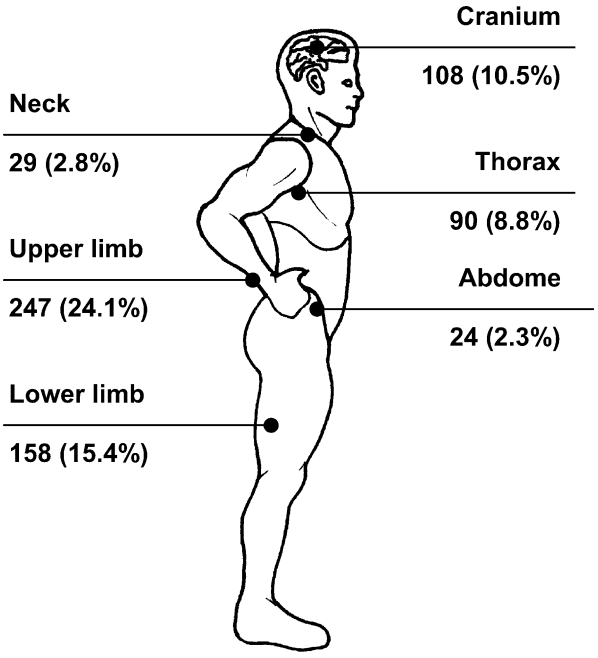

Fig. 3. Concomitant corporeal lesions in 1024 patients with maxillofacial fractures.

cases (47.9%), and surgical treatment details of 493 patients (48.1%) may be seen in Table IV.

Patients were followed-up routinely, from 1 week to 3.5 years, according to the severity of fracture, patient's medical status, and post-trauma complication management. Seventy-six patients experienced at least 1 complication (7.4%), out of a total number of 88 complications. Distribution of complications related to fracture sites is listed in Table V. Infection was the most prevalent complication overall (3.7% of patients), and it was predominantly found in patients who had mandibular fractures (81.6% of patients with infection were in the mandibular fracture group). Characteristically, maxillary fractures developed more complications related to malocclusion (62.5% of all maxillary complications) and the higher number of problems associated with facial asymmetry was observed in zygomatic complex fractures (58.3% of asymmetric results).

DISCUSSION

Epidemiologic surveys will vary with geographic region, population density, socioeconomic status and regional government, era in time, and type of facility in which the study was conducted. Comparison of data requires these factors to be considered.[1,6] Nonetheless, there seem to be some congruent trends.[9,12] This study was conducted between April 1999 and March 2004 in the metropolitan region of Piracicaba city, in the southeast of Brazil, covering a population of about 800 000

Table IV. Surgical treatment modalities according to the site of maxillofacial fractures

Site	*Closed reduction (No. patients)*	*Open reduction (No. patients)*	
		RIF	*Wire + IMF*
Mandible	11	277	1
Zygomatic complex	36	129	—
Nasal bone	45	1	—
Maxillary	3	33	—
Frontal	—	3	—
NOE	1	5	—

NOE, Nasal-orbital-ethmoid complex; *RIF,* rigid internal fixation; *IMF,* intermaxillary fixation.

inhabitants. This region includes both rural and urban areas, with more than half the population younger than 30 years, a ratio of men to women of 0.97:1, and regular road traffic legislation (use of restraints, speed limits of 55 mph and restrictions about driving under the influence of alcohol) since 1995 (Source: IBGE [Brazilian Institute of Geography and Statistics], Demographic Census 2000).

Demographic data of maxillofacial fractures in this region indicated that they were prevalent in men (4:1). These results agreed with data of various regions of the world.[3-5,8,9,15,17,19-21] It is interesting to note that the cultural and socioeconomic characteristics of the studied population may influence the rates of facial fractures in women. In countries such as Greenland,[22] Finland,[23] and Austria,[25] where women participate directly in social activities and consequently are more susceptible to traffic accidents and urban violence, the ratio of men:women incurring maxillofacial injuries can be as low as 2.1:1.[25] More recently, Adebayo et al.,[16] in Nigeria, reported that women's facial injury rates increased from 8% to 18% between 1978 and 1991, showing that certain economic conditions were necessary for women to play a more active part in society. Conversely, Ahmed et al.[10] published a much higher prevalence of men than other studies (11:1). The authors mentioned that the cultural features of the United Arab Emirates, where men usually do outdoor work and few women drive, may explain these results.

The most affected age group was from 21 to 30 years (32.7%), followed by patients ranging from 11 to 20 years (21.9%). Many surveys of maxillofacial fractures reported same results concerning age.[2,5,8,10,11,13,17,21,22,34] The possible explanation for this was that individuals between the ages of 11 and 30 years frequently take part in dangerous exercises and sports, drive motor vehicles carelessly, and are more likely to be involved in violence.[13] Furthermore, in the present research, data regarding occupation (Table I) also confirm these trends about gender and age. Men

Table V. Trauma-associated complications of 1024 patients with maxillofacial fractures

Complications	Site of fracture, no. complications						Total (% of complications)
	Mandible	ZC	Nasal	Maxilla	Frontal	NOE	
Infection	31	4	0	1	0	2	38 (43.2)
Malocclusion	13	1	0	5	0	0	19 (21.6)
Asymmetries	0	7	2	1	0	2	12 (13.6)
Hardware	6	2	0	0	0	0	8 (9.1)
Nonunion	6	0	0	0	0	0	6 (6.8)
Functional deficit	0	1	0	1	1	0	3 (3.4)
Malunion	2	0	0	0	0	0	2 (2.3)
TOTAL	58	15	2	8	1	4	88 (100.0)

ZC, Zygomatic complex; *NOE,* nasal-orbital-ethmoid complex.

aged 21 to 40 years in the active segment of the population represent a group with intense social interaction and higher rates of mobility, making them more susceptible to transport accidents and interpersonal violence, consequently leading to higher rates of maxillofacial fractures.[6,13,16,23] Since the etiological factor has important influence on maxillofacial fracture presentation, specific studies are able to identify some trends regarding age distribution. Iida et al.[18] studied 505 patients sustaining maxillofacial fractures resulting from falls in Germany, and noted a high proportion of older cases. Age distribution analysis showed 2 peaks of incidence in the fourth and eighth decades, supported by the knowledge that these incidents are often related to intrinsic factors such as neuromuscular and cognitive impairment.

Traffic accidents are clearly important in the series of maxillofacial fractures in developing[9,13,14,16] and developed[3,7,20,34] countries over the past 10 years, in line with the findings of the present study. Even though traffic rules and regulations have been enforced, seatbelt and helmet use encouraged, and passive safety devices have been introduced in motor vehicles, road traffic remained the most important cause of maxillofacial fractures.[14] Traffic accidents were the most prevalent cause of facial fractures in this study, being the cause of injury to 461 (45%) of the patients. Within the category of traffic accidents, bicycle and motorcycle accidents and collisions involving pedestrians deserved special attention over the previous few years, playing a prominent role in maxillofacial trauma etiology.[34] Bicycles are an important means of transportation in the Piracicaba region and this has led to a significant number of cases (33.6% of traffic accidents) in the results of this study.

Recently, assault has also been found to be the most common etiology of facial trauma in many urban centers in developed countries. Hächl et al.[11] in Austria, Iida et al.[18] in Germany, and Laski et al.[19] in the United States demonstrated that developed countries have an increased incidence of interpersonal violence as the leading cause of facial injury. With the implementation of programs to reduce road traffic accidents and the advances in restraints, the ease of acquiring weapons, and increasingly aggressive behavior in urban centers, assaults have replaced road accidents as the leading cause of maxillofacial trauma in these regions.

Maxillofacial fractures were prevalently represented by mandibular fractures (41.3%) in this study. Previous studies concur with these data.[2,5,9,10,13,14,16,19] Reports with high values of traffic accidents tend to present jaw fractures as the most frequent fracture site, with predominance of condylar involvement,[10,18,23,34] as may be seen in the present study data. In studies presenting significant interpersonal violence scores, mandibular fractures predominantly involving the angle and body regions, and zygomatic complex fractures may appear as the most prevalent fracture location.[1,6,8,24]

The incidence of injuries concomitant with maxillofacial fractures can vary widely, since there is ambiguity about the definition of these lesions in the literature and it depends on the frequency of certain injury mechanisms in the studies.[34] Motor vehicle accidents are considered to be the most frequent cause of associated injuries in maxillofacial trauma.[3,13,15,16] Populations strongly influenced by work-related accidents[11] or daily life and play accidents[25] presented lower rates of associated systemic lesions (20.7% and 19.6%, respectively). Haug et al.[1] compared the etiological mechanism of injuries to their concomitant lesions in 402 patients with facial fractures. They found that motor vehicle accidents were responsible for 68.1% of these lesions, while sports accidents accounted for 4.4%. The present study findings are parallel to those of Haug et al.,[1] since traffic accidents were related to 61.8% and sports accidents to 6.3% of associated corporeal lesions.

In the past 15 years, changes in maxillofacial trauma management have been strongly influenced by innovations in materials and technology,[16,38] since objectives such as early recovery, segment stability, and patients' comfort have been considered paramount in the

treatment of maxillofacial fractures.[35,36,39] Ansari[9] reported in Iran, from 1987 to 2001, a marked predilection for "simple techniques" and most patients were treated by applying closed procedures. Although treatment of facial fractures varies from surgeon to surgeon, it also depends on the available instruments. Reports from the United Arab Emirates[10] and Nigeria[16] confirmed this practice and stated that open reduction and rigid internal fixation of facial fractures has not become popular in most developing countries mainly because of cost.[4] On the other hand, Torgersen and Tornes[8] advocated that miniplates' osteosynthesis has become the standard procedure in their department, being used 4 times more frequently than wire in open reduction and bone fixation.

One of the most noticeable features of this study was that 99.8% (399 patients) of 400 cases treated under open reduction and bone segment fixation were done by rigid means of internal fixation. Routinely, patients with fractures involving the dentate segments, who were treated with RIF were placed in IMF intraoperatively. On completion of the procedure, IMF was released in all but one case. This was the management of a 25-year-old male motorcycle accident victim, diagnosed with symphyseal mandibular fracture associated with a left zygomatic complex fracture and a sagittal maxillary fracture. These sites were treated with 2.0-mm titanium miniplates. Additional IMF was instituted for 30 days because of poor patient compliance with treatment and his follow-up was uneventful. Only one isolated patient was not treated with RIF, but underwent wire osteosynthesis of symphyseal and right body mandibular fractures after interpersonal violence. Inadequate sterilization of the plate and screw package was noted when the patient was already under general anesthesia. Thus, surgeons decided on a wiring technique and IMF postoperatively for 6 weeks. No complications were found during the patient's follow-up. Therefore, rigid means of internal fixation is the method of choice for open reduction of maxillofacial fractures by this Division.

According to the results of the present study, overall maxillofacial fracture complications were found in 7.4% of patients, lower than data presented by other authors, ranging from 11%[8] to 12.8%.[32] Local infections were the major complication type, occurring in 3.7% of cases. This corroborates the outcomes achieved by Torgersen and Tornes,[8] who obtained an infection rate of 4% in Norway, and Zachariades et al.,[32] who noted that 3.3% of patients developed infection after rigid internal fixation in Greece.

The characteristics of the fracture locations and degree of bone fragmentation also contribute to development of postoperative complications. More specifically, surgical repair of lesions involving the nasal-orbital-ethmoid (NOE) complex are difficult, and cosmetic and functional sequelae can occur more frequently after injury. This study revealed that NOE fractures demonstrated the highest rate of complications of all facial fractures (36.4%), particularly due to asymmetries and infection, which could be attributed to the complexity of the anatomical site and bony comminution found in these injuries.[9,17,32,37] Besides, comparison of complication rates among different studies should consider the casuistic, methodology, and subjectivity of data interpretation.[8,32]

Nutritional deficiencies and changes in general health, substance abuse, and life-style, personal/oral hygiene, and overall compliance (failed to take medications, to maintain feeding restriction, and to return for follow-up) may markedly accentuate complication rates.[40] Ahmed et al.[10] observed a low rate of complications (5.6%), particularly of postoperative infections, emphasizing the use of prophylactic antibiotics and patients' compliance with postoperative instructions. It seems plausible that these aspects have a strong association with the cases of infection, nonunion, and poor union, which represented most of patients with complications. Thus, identification of these features can contribute to maximize patients' management and prevention of facial fracture complications. Finally, the methodology of each study interferes considerably with complication scores, since similar treatment protocols and well-defined complication records should be confronted when a pertinent comparison of population management is desired.

The present study supports that regular epidemiologic evaluations of maxillofacial fractures allow a detailed analysis of these lesions, providing important support to install clinical and research priorities, since risk factors and patterns of presentation can be identified. According to these data it seems reasonable to assume that road traffic legislation enforcement and continuous public education toward the use of restraining devices should be encouraged. Additionally, it should be emphasized that these patients need postoperative care and assistance and they should be closely followed, particularly in cases of facial fractures submitted to open reduction and rigid fixation in any region around the world.

REFERENCES

1. Haug RH, Prather J, Indresano T. An epidemiologic survey of facial fractures and concomitant injuries. J Oral Maxillofac Surg 1990;48:926-32.
2. 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;21:77-9.
3. 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;24:409-12.

4. 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: 310-4.
5. 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;31:206-9.
6. Ellis E III, El-Attar A, Moos KF. An analysis of 2,067 cases of zygomatic-orbital fractures. J Oral Maxillofac Surg 1985;43: 417-28.
7. Iida S, Matsuya T. Pediatric maxillofacial fractures: their etiological characters and fracture patterns. J Craniomaxillofac Surg 2002;30:237-41.
8. Torgersen S, Tornes K. Maxillofacial fractures in a Norwegian district. Int J Oral Maxillofac Surg 1992;21:335-8.
9. Ansari MH. Maxillofacial fractures in Hamedan province, Iran: a retrospective study (1987-2001). J Craniomaxillofac Surg 2004;32:28-34.
10. 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;98:166-70.
11. Hächl O, Tuli T, Schwabegger A, Gassner R. Maxillofacial trauma due to work-related accidents. Int J Oral Maxillofac Surg 2002;31:90-3.
12. 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.
13. Oji C. Jaw fractures in Enugu, Nigeria, 1985-95. Br J Oral Maxillofac Surg 1999;37:106-9.
14. Fasola AO, Nyako EA, Obiechina AE, Arotiba JT. Trends in the characteristics of maxillofacial fractures in Nigeria. J Oral Maxillofacial Surg 2003;61:1140-3.
15. Karyouti SM. Maxillofacial injuries at Jordan University Hospital. Int J Oral Maxillofac Surg 1987;16:262-5.
16. 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.
17. Afzelius L, Rosén C. Facial fractures. Int J Oral Surg 1980;9: 25-32.
18. Iida S, Hassfeld S, Reuther T, Schweigert H, Haag C, Klein J, et al. Maxillofacial fractures resulting from falls. J Craniomaxillofac Surg 2003;31:278-83.
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;62:685-8.
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;30:286-90.
21. Fridrich KL, Pena-Velasco G, Olson RAJ. Changing trends with mandibular fractures. J Oral Maxillofac Surg 1992;50:586-9.
22. Thorn JJ, Mogeltoft M, Hansen PK. Incidence and aetiological pattern of jaw fractures in Greenland. Int J Oral Maxillofac Surg 1986;15:372-9.
23. Lindqvist C, Sorsa S, Hyrkas T, Santavirta S. Maxillofacial fractures sustained in bicycle accidents. Int J Oral Maxillofacial Surg 1986;15:12-8.
24. Brook IM, Wood N. Etiology and incidence of facial fractures in adults. Int J Oral Surg 1983;12:293-8.
25. Gassner R, Tuli T, Hächl 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.
26. Gassner R, Tuli T, Hächl O, Moreira R, Ulmer H. Craniomaxillofacial trauma in children: a review of 3,385 cases with 6,060 injuries in 10 years. J Oral Maxillofac Surg 2004;62:399-407.
27. Champy M, Lodde JP, Schmidt R, Jaeger JH, Muster D. Mandibular osteosynthesis by miniature screwed plates via a buccal approach. J Maxillofac Surg 1978;6:14-21.
28. Michelet FX, Deymes J, Dessus B. Osteosynthesis with miniaturized screwed plates in maxillo-facial surgery. J Maxillofac Surg 1973 Jun;1(2):79-84.
29. Bhatt V, Langford R. Removal of miniplates in maxillofacial surgery: University Hospital Birmingham experience. J Oral Maxillofac Surg 2003;61:553-6.
30. Jensen J, Pedersen-Sindet S, Christensen L. Rigid fixation in reconstruction of craniofacial fractures. J Oral Maxillofac Surg 1992;50:550-4.
31. Tuovinen V, Nørholt SE, Pedersen-Sindet S, Jensen J. A retrospective analysis of 279 patients with isolated mandibular fractures treated with titanium miniplates. J Oral Maxillofacial Surg 1994;52:931-5.
32. Zachariades N, Papademetriou I, Rallis G. Complications associated with rigid internal fixation of facial bone fractures. J Oral Maxillofac Surg 1993;51:275-8.
33. Gerbino G, Roccia F, Benech A, Caldarelli C. Analysis of 158 frontal sinus fractures: current surgical management and complications. J Craniomaxillofac Surg 2000;28:133-9.
34. Van Beek GJ, Merkx CA. Changes in the pattern of fractures of the maxillofacial skeleton. Int J Oral Maxillofac Surg 1999; 28:424-8.
35. Gabrielli MAC, Gabrielli MFR, Marcantonio E, Holuchi-Vieira E. Fixation of mandibular fractures with 2.0 mm miniplates: review of 191 cases. J Oral Maxillofac Surg 2003;61:430-6.
36. Fonseca RJ, Walker RV. Oral and maxillofacial trauma. 2nd ed. Philadelphia: W.B. Saunders Company; 1997.
37. Kaban LB, Pogrel MA, Perrot DH. Complications in oral and maxillofacial surgery. Philadelphia: W.B. Saunders Company; 1995.
38. Laskin DM, Best AM. Current trends in the treatment of maxillofacial injuries in the United States. J Oral Maxillofac Surg 2000;58:207-15.
39. Prein J. Manual of internal fixation in the cranio-facial skeleton. Berlin, Germany: Springer-Verlag; 1998.
40. Passeri LA, Ellis E III, Sinn DP. Relationship of substance abuse to complications with mandibular fractures. J Oral Maxillofac Surg 1993;51:22-5.

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