

Etiology and Patterns of Maxillofacial Fractures in 518 patients in Korea

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Abstract

Purpose: Different patterns in the causes of maxillofacial injury are thought to correlate with socioeconomic status and regional environment. This study investigated maxillofacial fractures in order to analyze maxillofacial trauma characteristics and the relationship between the causes and injury patterns in Korea.

Material and methods: A total of 518 patients with maxillofacial fractures who were treated at the Seoul National University Boramae Hospital between 1996 and 2004 were retrospectively analyzed. Data were obtained from the patients' medical records and radiographs. The male to female ratio in the patient group was 2.78:1, and the mean age was 32.3 years.

Results: Midfacial fractures were the most common location of injury (46.1%). The most common etiologic factor was an activity associated with daily life (42.6%) including falls, stumbling, and collisions. The second most common cause was assault (32.4%), followed by traffic accidents (13.7%). In the case of midfacial fractures and mandibular fractures, assault was the most common etiologic factor, whereas in the case of alveolar bone fractures, activities associated with daily life were the most common cause. With regard to age groups, assault was the most common cause for patients between 10 and 39 years old and an activity associated with daily life was the most common cause in those under 10 years and over 40 years.

Conclusions: This study concluded that activities associated with daily life and assault causes a large proportion of Korean maxillofacial injuries and that preventive measures should be implemented in order to minimize these risks.

Key words

Maxillofacial fractures, Etiology, Midfacial fractures, Mandibular fractures, Alveolar bone fractures

INTRODUCTION

Maxillofacial trauma is among the most devastating of traumatic injuries and may have long-term consequences. This relative severity is due not only to the technical difficulty of repair but also due to the subsequent emotional and functional consequences associated with long-term disfigurement to patients, as well as the socioeconomic impact of such injuries on the health care system. Epidemiological reviews of these injuries are

needed to identify the risk factors leading to such trauma. These reviews are useful for reaffirming previously established trends and identifying new patterns of disease frequency^{1,2}. Additionally, the success of treatment and the implementation of preventive measures are more dependent on the epidemiological assessments^{3,4}. However, few studies involving a large series of patients with maxillofacial injuries have been conducted in Korea. Accordingly, there is little information available on the relative incidence and characteristic patterns of maxillofacial injuries.

The aim of this study was to review maxillofacial fractures that were treated in the past 9 years and to analyze the relationship between the causes and injury patterns of maxillofacial trauma in order to provide useful information for reducing the risk of such injuries.

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PATIENTS AND METHODS

This study included data for 518 maxillofacial injury patients that were treated by the Department of Oral and Maxillofacial Surgery at Seoul National University Boramae Hospital from January 1, 1996 to December 31, 2004. The patients' medical records and radiographs, as well as their case histories, etiological features and injury patterns were analyzed. The causes of their injuries were classified as follows: traffic accidents, activities associated with daily-life (ADLs, which include falls, stumbling, collision, and playing accidents), assaults, sports, and work-related accidents⁴⁾.

The maxillofacial fractures were divided into three categories according to their anatomic location: midfacial fractures, mandibular fractures, and isolated alveolar bone fractures. Midfacial fractures included maxillary fractures, zygomatic fractures, orbital rim fractures, and isolated nasal bone fractures. The mandibular fracture lines were classified into six anatomical sites: symphysis, body, angle, ramus, coronoid process, and condyle²⁾. In the case of isolated alveolar bone fractures, the following concomitant injuries were examined: tooth fractures, subluxation of the teeth, avulsion of the teeth, and laceration of the intraoral mucosa and gingiva.

RESULTS

1. Pattern of injury

Among the 518 patients, there were 381 males (73.6%) and 137 females (26.4%), and the overall male to female ratio was 2.78:1. The patients' ages ranged from 7 months to 80 years. The mean age of the patients was 32.3 years (median age: 30). A total of 331 patients (63.9%) were between 20 and 49 years. The largest subgroup of patients was aged 20-29 years (25.9%), followed by those aged 30-39 years (17%) (Table 3). Midfacial fractures (46.1%) were the most common anatomic injury, followed by mandibular fractures (27.2%) and alveolar bone fractures (26.6%) (Table 1). Among the midfacial fractures, zygomatic fractures were the most common, followed by nasal bone fractures, maxillary fractures and orbital rim fractures (Table 6). A total of 9 patients (1.7%) had combined fractures of the midface and the mandible.

2. Causes of injury

The most common cause of injury was an activity associated with daily life (ADLs), which include falls, stumbling, collisions, and playing accidents (42.6%). The sec-

Table 1. Classification of the maxillofacial injuries for 518 patients

| Type of injury | Number of patients | | | Age (mean, years) |
|-------------------------|--------------------|--------|-------|-----------------------------|
| | Male | Female | Total | |
| Midfacial fractures | 187 | 52 | 239 | 31.5 |
| Mandibular fractures | 118 | 23 | 141 | 33.7 |
| Alveolar bone fractures | 76 | 62 | 138 | 34.0 |
| | 381 | 137 | 518 | 32.3 (SD: 13.9, Median: 30) |

Table 2. Distribution of maxillofacial injuries according to the cause of injury and the year the injury occurred

| Cause / Year | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | Sum |
|--------------|------|------|------|------|------|------|------|------|------|-----|
| TA | 14 | 11 | 4 | 14 | 5 | 11 | 4 | 2 | 6 | 71 |
| ADL | 15 | 23 | 30 | 17 | 25 | 14 | 25 | 35 | 38 | 222 |
| Assault | 7 | 26 | 24 | 29 | 21 | 12 | 14 | 18 | 17 | 168 |
| Work | 2 | 6 | 4 | 0 | 4 | 1 | 4 | 3 | 4 | 28 |
| Sports | 1 | 1 | 4 | 0 | 7 | 3 | 3 | 4 | 6 | 29 |
| Sum | 39 | 67 | 66 | 60 | 62 | 41 | 50 | 62 | 71 | 518 |

TA: Traffic accidents, ADL: activities associated with daily-life, Assault: assault-related injuries

Work: work-related injuries, Sports: sports-related injuries

ond most common cause was assault (32.4%) followed by traffic accidents (13.7%) (Table 2). In the case of mid-facial fractures and mandibular fractures, assault was the most common etiology, whereas in the case of alveolar bone fractures, ADLs were the most common cause (Table 5). According to age group, ADLs were the most common cause in patients under the age 10 and over the age 40 (65.8%). Assault was the most common etiologic factor in those between ages 10 and 39 (35.6%) (Table 4).

3. Midfacial fractures

Zygomatic fractures (33.9%) and nasal bone fractures (29.3%) were more common than other injuries in the 239 midfacial fractures. Among these midfacial fractures, maxillary fractures (37.5%) and zygomatic fractures (40.7%) were primarily associated with ADLs. On the

other hand, assault was the most common cause of orbital rim fractures (60%) and nasal fractures (34.3%) (Table 6). In the case of nasal bone fractures, most patients were between ages 10 and 29 years (44/70, 62.9%), and in orbital rim fractures, 35% patients (14/40) were between ages 20 and 29 years. Among the 29 sports-related maxillofacial fractures, 12 cases (41.4%) were nasal bone fractures. These injuries had a stronger association with sports activities than did other fractures (Table 4, 6).

4. Mandibular fractures

A total of 141 mandibular fractures, including 132 cases of isolated mandibular fractures and 9 cases of the combined midfacial and mandibular fractures, were reviewed. Single fracture sites were observed in 75

Table 3. Distribution of maxillofacial injuries according to age and type of fracture

| Age (years) | Midfacial fractures | Mandibular fractures | Alveolar bone fractures | Sum |
|-------------|---------------------|----------------------|-------------------------|-----|
| 0-9 | 7 | 1 | 13 | 21 |
| 10-19 | 39 | 16 | 21 | 76 |
| 20-29 | 70 | 43 | 21 | 134 |
| 30-39 | 52 | 32 | 15 | 99 |
| 40-49 | 42 | 32 | 24 | 98 |
| 50-59 | 19 | 11 | 22 | 52 |
| 60- | 10 | 6 | 22 | 38 |
| Sum | 239 | 141 | 138 | 518 |

Table 4. Distribution of maxillofacial fractures according to age and the cause of the injury

| Cause / Age | 0-9 | 10-19 | 20-29 | 30-39 | 40-49 | 50-59 | 60- | Sum |
|-------------|-----|-------|-------|-------|-------|-------|-----|-----|
| TA | 3 | 11 | 16 | 21 | 11 | 5 | 4 | 71 |
| ADL | 17 | 21 | 48 | 30 | 49 | 31 | 26 | 222 |
| Assault | 0 | 30 | 55 | 33 | 31 | 13 | 6 | 168 |
| Work | 0 | 1 | 6 | 11 | 6 | 2 | 2 | 28 |
| Sports | 1 | 13 | 9 | 4 | 1 | 1 | 0 | 29 |
| Sum | 21 | 76 | 134 | 99 | 98 | 52 | 38 | 518 |

TA: Traffic accidents, ADL: activities associated with daily-life, Assault: assault-related injuries
 Work: work-related injuries, Sports: sports-related injuries

patients (53.2%), and two or more fracture sites were observed in the other 66 patients (46.8%). A total of 211 fracture sites were observed in the 141 mandibular fracture patients (Table 7). In the case of single fractures, 35 patients had angle fractures (46.7%) and 26 patients had symphysis fractures (34.7%). In patients with multiple fractures, the most common combinations of fracture sites were the symphysis and the angle (30 patients, 45.5%), followed by the symphysis and condyle (25

patients, 37.9%). Among all 211 fracture sites, the most common site was the symphysis (41.2%), followed by the angle (32.2%), and the condyle (18.5%). A total of 107 patients (75.9%) were aged between 20 and 49 years, and those between 20 to 29 years comprised the largest subgroup (43/141, 30.5%). The most common cause was assault (42.7%), followed by ADLs (41.2%) and traffic accidents (18.5%) (Table 7).

Table 5. Distribution of maxillofacial injuries according to the type of injury and the cause of the injury

| Cause / Site | Midfacial fractures | Mandibular fractures | Alveolar fractures | Sum |
|--------------|---------------------|----------------------|--------------------|-----|
| TA | 39 | 16 | 16 | 71 |
| ADL | 81 | 57 | 84 | 222 |
| Assault | 85 | 63 | 20 | 168 |
| Work | 17 | 2 | 9 | 28 |
| Sports | 17 | 3 | 9 | 29 |
| Sum | 239 | 141 | 138 | 518 |

TA: Traffic accidents, ADL: activities associated with daily-life, Assault: assault-related injuries, Work: work-related injuries, Sports: sports-related injuries

Table 6. Distribution of maxillofacial injuries according to the anatomic location of the injury and the cause of the injury

| Cause/Sites | Maxillary | Zygomatic | Orbital | Nasal | Sum |
|-------------|-----------|-----------|---------|-------|-----|
| TA | 10 | 18 | 4 | 7 | 39 |
| ADL | 18 | 33 | 9 | 21 | 81 |
| Assault | 14 | 23 | 24 | 24 | 85 |
| Work | 5 | 6 | 0 | 6 | 17 |
| Sports | 1 | 1 | 3 | 12 | 17 |
| Sum | 48 | 81 | 40 | 70 | 239 |

TA: Traffic accidents, ADL: activities associated with daily-life, Assault: assault-related injuries, Work: work-related injuries, Sports: sports-related injuries

Table 7. Distribution of mandibular fractures according to the anatomy of the mandible involved and the cause of the injury

| Cause/Site | Symphysis | Body | Angle | Ramus | Condyle | Coronoid | Sum |
|------------|-----------|------|-------|-------|---------|----------|-----|
| TA | 10 | 1 | 5 | 0 | 7 | 0 | 23 |
| ADL | 37 | 7 | 28 | 1 | 14 | 0 | 87 |
| Assault | 37 | 4 | 32 | 2 | 15 | 0 | 90 |
| Work | 1 | 0 | 1 | 1 | 1 | 1 | 5 |
| Sports | 2 | 0 | 2 | 0 | 2 | 0 | 9 |
| Sum | 87 | 12 | 68 | 4 | 39 | 1 | 211 |

TA: Traffic accidents, ADL: activities associated with daily-life, Assault: assault-related injuries, Work: work-related injuries, Sports: sports-related injuries

Table 8. Concomitant injuries associated with alveolar bone fractures according to the cause of the fracture

| Cause / Injuries | Tooth fractures | Tooth subluxation | Tooth avulsion | Laceration |
|------------------|-----------------|-------------------|----------------|------------|
| TA | 10 | 5 | 5 | 2 |
| ADL | 70 | 23 | 6 | 16 |
| Assault | 13 | 7 | 3 | 7 |
| Work | 8 | 2 | 3 | 3 |
| Sports | 6 | 6 | 1 | 2 |
| sum | 107 | 43 | 18 | 30 |

TA: Traffic accidents, ADL: activities associated with daily-life, Assault: assault-related injuries

Work: work-related injuries, Sports: sports-related injuries,

Laceration: laceration of intraoral mucosa or gingiva

5. ALVEOLAR BONE FRACTURES

A total of 138 patients with alveolar bone fractures were examined. Alveolar bone fractures were observed in all age groups, but were more common in those under the age of 10 (13 patients, 9.4%) and in those over the age of 40 years (22 patients, 15.9%) compared to the other age groups. ADLs were the most common cause of alveolar injuries (60.9%), followed by assault (14.5%), and traffic accidents (11.6%). Tooth fractures were the most common concomitant injuries associated with alveolar bone fractures, followed by tooth subluxation (Table 8).

DISCUSSION

The reported etiology of traumatic injuries varies between studies. Some have reported that automobile-associated traffic accidents were the most common cause of maxillofacial injuries, 5-8 while others have reported that assault-related maxillofacial fractures were the most common⁹⁻¹¹. In this study, activities associated with daily life (ADLs), which included falls, stumbling, collision, and playing accidents, were the most common etiology, followed by assaults and traffic accidents. In midfacial and mandibular fracture patients, assault was the most common etiologic factor, whereas in alveolar bone fractures ADLs were the most common cause. These results were associated with the regional socioeconomic status and location of a facility for trauma patients. This study was carried out at the primary trauma center serving the densely populated region of southwestern Seoul.

Overall, nearly three times as many men as women experienced facial trauma, and this male preponderance existed in all age groups. Those aged 20-29 years were

the most common. However, there were differences in the etiologic factors and fracture patterns according to age. Alveolar bone fractures were the most common injuries in those younger than 10 years of age. This fracture pattern corresponds with the anatomical characteristics of the facial skeleton in this age group^{12,13}. In addition, the prevalent etiologic factors in this age group were playing accidents, among ADLs. In other studies of pediatric fractures, the most common fractures of the facial skeleton were mandibular fractures involving the condyle, followed by alveolar bone fractures^{12,14}. The relatively low incidence of mandibular fractures in this study can be attributed to differences in etiologic factors, and the lower percentage of traffic accidents. Assault was the most common cause of maxillofacial fracture in the subgroup aged 10 to 39 years, whereas in those aged over 40, ADLs were the most common etiology. Alcohol was an important contributing factor to both assault and ADL-related accidents in these patients. Approximately 30% of patients with facial bone fractures (26.9% of midfacial fractures, 30.2% of mandibular fractures) were caused by ADL-related accidents or assaults that were associated with drinking. These results were similar to other reports in which 33-42% of maxillofacial injuries were associated with alcohol^{15,16}. In a study of trends in maxillofacial fractures, an alleged assault due to alcohol and unemployment resulted in an increase in facial bone fractures. This study highlights the increasing need for a prevention program¹. Moreover, referral systems and educational programs for alcohol abuse are essential preventive measures.

In this study, midfacial fractures were more common than other injuries. This is similar to other studies in which middle third fractures were most common among

maxillofacial injuries³). In addition, many studies attributed the increase in middle third fractures to an increasing number of zygomatic fractures, and explained that this increase was due to the increasing number of road traffic accidents^{3,17,18}). In this study as well, zygomatic fractures (33.9%) were the most common injury among midfacial fractures, followed by nasal fractures, maxillary fractures, and orbital rim fractures. However, the most common etiologic factors for zygomatic and maxillary fractures were ADLs. In isolated nasal and orbital rim fracture cases, assault was the most common cause. Unilateral maxillary anterior wall fractures and unrotated body fractures of the zygoma comprised a large percentage of the zygoma and maxilla fractures in this study. These fracture patterns were closely associated with the etiologic factors, and were caused by relatively weak impact forces. This type of impact force causes a relative in-bending and disruption at the weakest anatomic locations. In contrast to these types of injuries, rotated and displaced fractures of the zygomatic body and Le Fort type maxillary fractures are generally caused by high-energy impacts such as falls from heights and car crashes¹⁹). In this study, falls from standing heights, stumbling, crashing, and playing accidents were the most common etiological factors for these types of fractures. In addition, the relationship between the fracture patterns and the etiologic factors might be due to the lower incidence of combined midfacial and mandibular fractures compared with other studies. The most common facial fractures associated with zygomatico-orbital fractures were mandibular fractures, comprising 8.7%³ and 33.1%⁷). Road traffic accidents were the most important etiologic factors in these reports^{3,7}). However, in this study, 3.8% of maxillofacial fractures (9 patients out of 239 midfacial fractures) showed combined fractures of the midface and the mandible.

Among the assault and ADL-related mandibular injuries, the most commonly involved sites were the symphysis and angle. The symphysis and condyle fractures were common in the cases of traffic accidents. In most symphysis fracture cases, the lower left canine area was the most frequently involved site. These results support other Korean studies that reported that the most common fractures caused by alleged assaults involved the symphysis^{20,21}). In contrast, the largest proportion of traffic accident-related mandibular fractures involved the condyle, followed by the mandibular angle and the canine region^{5,22}). In the case of car and bicycle accidents,

impact to the chin caused a high incidence of condylar fractures^{5,23}).

With respect to etiologic factors, work-related and sports injuries comprised a lower proportion of maxillofacial fractures than did assault and ADL injuries. However, there was a strong association between sports-related injury and nasal and alveolar bone fractures. Among the 29 patients with sports injuries, nasal fractures and alveolar bone fractures were observed in 12 cases (41.4%) and 9 cases (31.0%), respectively. With increasing leisure time, the growing number of sports facilities available, and the desire for a sense of health and well-being, an increasing number of people are expected to participate in sports activities. This suggests a future increase in sports injuries and changes in the observed pattern of maxillofacial fractures.

This retrospective study demonstrated that maxillofacial fractures in southwestern Seoul, Korea have a characteristic etiology and injury pattern. The characteristics of the injuries were strongly influenced by local socioeconomic status. Implementation of preventive measures according to these characteristics is suggested to minimize the risk of maxillofacial injuries.

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