Six Years of Experience in Treating Facial Trauma in the Province of Brescia, Italy

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Abstract

Facial trauma is an enormous public health problem with overwhelmingly negative physical and psychological impacts. The authors retrospectively analyzed the incidence, etiology, clinical presentations, and characteristics of facial fractures along with sociodemographic, economic, and cultural factors. They analyzed facial fractures treated from June 2010 to December 2016 at the operative unit. Maxillofacial Adult Surgery Unit, Spedali Civili Brescia, Italy, with particular attention to the associations among age, etiology, fracture site, and clinical management.

Keywords

- trauma
- maxillofacial
- mandible
- maxilla
- zygoma
- nose

Facial fractures vary in type, severity, and cause, depending on the population studied[1] and are influenced by geographical area, cultural differences, lifestyles, and economic trends.[2] An understanding of the causes, severity, and temporal distribution of facial trauma can help to identify clinical and research priorities allowing the implementation of effective preventive measures. Data collection over time is important.[3] Analyses of both prospective and retrospective data can yield information on current trends in facial trauma.[4]

Facial trauma is a major public health problem, both physically and psychologically, and has major socioeconomic consequences in terms of the costs of hospitalization and treatment and loss of income.[5,6] We retrospectively analyzed facial mass fractures treated from June 2010 to December 2016 at the operative unit. Maxillofacial Adult Surgery Unit, Spedali Civili Brescia, Italy, with particular attention to the associations among age, etiology, fracture site, and clinical management. We compare our findings with those of several other epidemiological studies on facial trauma from both Europe and elsewhere.

Materials and Methods

The inclusion criteria were facial trauma (either mono- or polytrauma), age $\geq$ 18 years, availability of clinical and radiological data, at least one facial bone fracture, and treatment via open or closed surgery. Patients who did not require intervention nor had follow-up only were excluded. We enrolled 1,262 patients, and considered the year, month, and duration of hospitalization, age and sex, etiology of trauma, the number and locations of fractures, presence/absence of skin lesions requiring sutures, the Facial Injury Scoring System (FISS) score (an index of facial trauma severity), and the type of treatment.

Results

The 1,262 patients presented with 2,615 fractures, all of which were treated. In all, 1,003 (79%) patients were males and 259 (21%) were females; the male to female ratio was 3.87:1. The mean patient age was 40.7 years; the average age of females was higher than that of males (46.5 and 39 years, respectively). Most admissions were at the beginning (June; 141 admissions) and the end of summer (September; 138 admissions), respectively. The average duration of hospitalization was 7 days (males, 6.8 days; females, 7.7 days). In all, 299 (24%) injuries were of unknown cause; the rest stemmed from road accidents (252; 20%), aggressive encounters (182; 14.4%), sports (178; 14.1%), nonroad accidents (169; 13.4%), domestic accidents (72; 5.7%), other causes (30; 2.4%), and iatrogenic causes (6; 0.5%).

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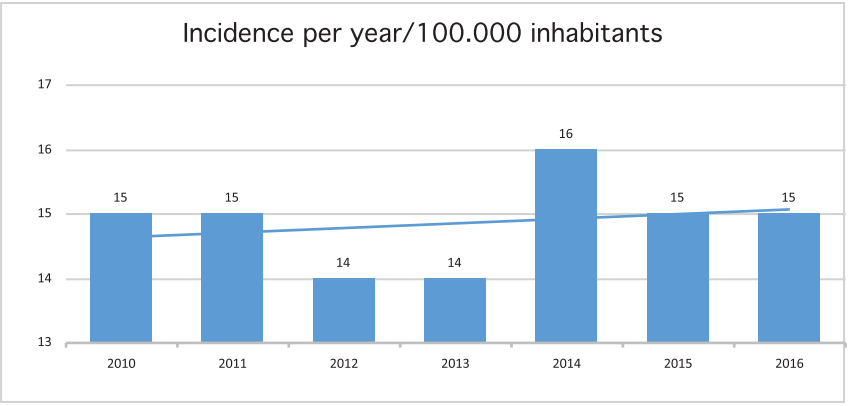

Fig. 1 The incidence of facial trauma in the province of Brescia, Italy, from 2010 to 2016.

The site most affected was the middle third of the face (1,986 fractures) followed by the jaw (516 fractures), teeth (68 fractures and avulsions), and the upper third of the face (45 fractures). In the middle third of the face, the orbitozygomatic complex was the most common fracture site (38%). The most frequent mandibular fracture site was the parasymphysis (22%). Avulsions and dental fractures principally affected maxillary elements. Most frontal bone fractures were comminuted. Trauma severity was scored using the FISS; the average score was 2.07 (1–18; standard deviation [SD] 1.88). Of the 1,262 patients, 838 underwent open and 424 had closed surgery. We placed 1,303 plates, 67 grids, and 88 Gore-Tex patches.

The annual numbers of cases of facial trauma recorded are not directly comparable because data collection in 2010 commenced in June. Therefore, we calculated the annual incidence per 100,000 people (►**Fig. 1**). The incidence in 2010 was obtained by multiplying the initial figure by 2.4 (12/5).

The values ranged from 14 to 16/100,000, and were thus similar. However, the trend line indicates a slight increase over time. As shown in ►**Fig. 2**, facial trauma was more common in summer, particularly in June (141 cases) and September (138 cases).

Males experienced more maxillofacial trauma; the male to female ratio ranged from a minimum of 3.17:1 in 2011 to a maximum of 5.76:1 in 2014. The average age of patients ranged between 20 and 50 years and the age peak of 43 years was attained in 2015. The average age of affected females was higher than that of males, most prominently in 2005 (females 54.3 years; males 40.19 years). The distribution of facial trauma by age group is shown in ►**Fig. 3**.

In all, 299 (24%) injuries were of unknown cause; the rest stemmed from road accidents (252; 20%), aggressive encounters (182; 14.4%), sports (178; 14.1%), nonroad accidents (169; 13.4%), domestic accidents (72; 5.7%), other causes (30; 2.4%), and iatrogenic causes (6; 0.5%; ►**Fig. 4**).

Road accidents were the main cause of trauma (252 patients; two spikes were evident in 2014 and 2016 [46 patients each]). Road accidents were most common in summer. Of all such accidents (►**Fig. 5**), 141 were not further characterized, 68 were bicycle accidents, 24 were motorcycle accidents, 7 were car accidents, 7 involved pedestrians, 3 involved trucks, and 2 involved tractors.

For males, most road accidents were bicycle accidents, followed by motorbike, and car accidents. For females, the order was: bicycle, motorbike, and pedestrian. The second most common cause of accidents was aggression (182 patients; 151 males and 31 females). Only five males described the aggressors (known persons in two cases and unknown in three). Of the 31 women victims, only 6 described the aggressors (all husbands/cohabitants). Sports accidents were the third most common cause of facial trauma (178 cases; 169 males and 9 females), followed by falls (169 cases; 112 males and 57 females), other accidents (106 cases), syncopal episodes

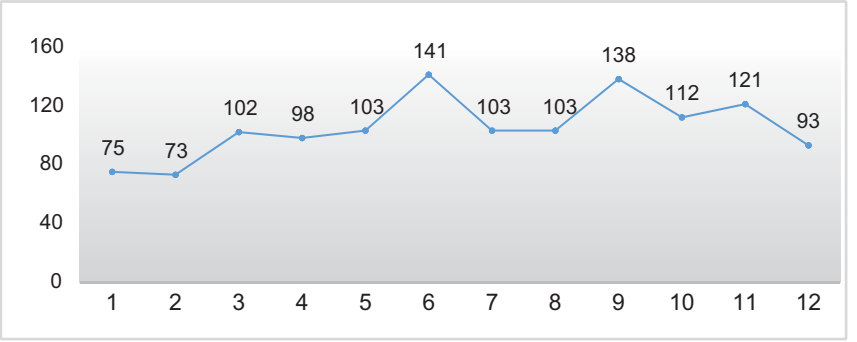

Fig. 2 Fewer patients presented in January and February than in other months (75 and 73 patients respectively). Horizontal axis denotes the months and the vertical axis is the number of patients.

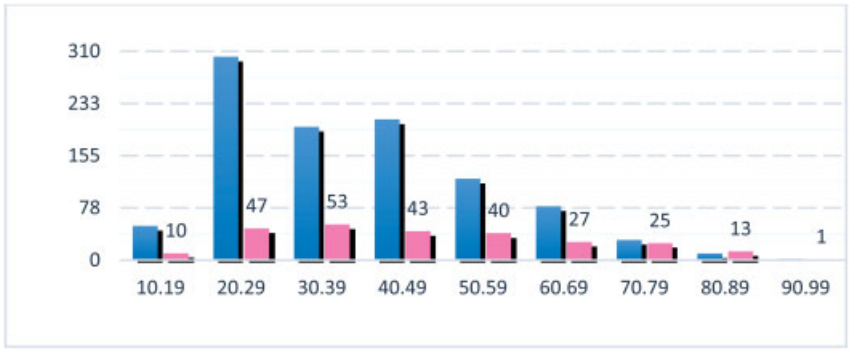

Fig. 3 Distribution of facial trauma by age group in males (blue) and females (pink).

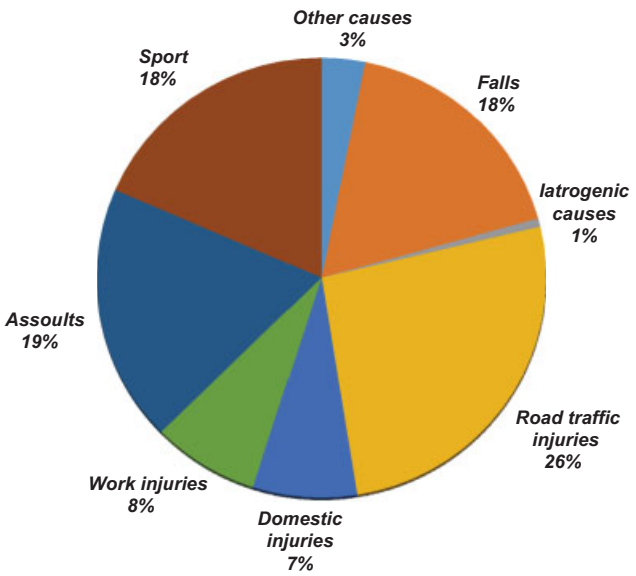

Fig. 4 Etiologies of facial trauma in the Province of Brescia, Italy, from 2010 to 2016.

(36 cases), accidents at work (74 cases), domestic accidents (72 cases), nondomestic accidents (30 cases including 13 general accidents, 5 gardening accidents, 4 horseback-riding accidents, 3 firearms accidents, 2 accidents for which data were lacking, 1 bull's kick, 1 accident suffered during an epileptic seizure, and 1 attempted suicide), and iatrogenic causes (six cases: two fractures after dental avulsion and four attributable to osteoporosis).

The most affected site was the middle third of the face (1,986 fractures, 76%), followed by the mandibular region (516 fractures, 19%), oral cavity (68 fractures and avulsions, 3%), and the frontal region (45 fractures, 2%). The 1,986 fractures in the middle third of the face were distributed as shown in ►**Fig. 6**.

A total of 45 frontal bone fractures were treated, of which 12 were noncomminuted and 33 were not. In the 1,003 males, there were 1,642 (77.8%) fractures in the middle third of the face, 378 (17.9%) jaw fractures, 51 (2.41%) alveolar fractures including dental avulsions, and 40 (1.9%) frontal fractures.

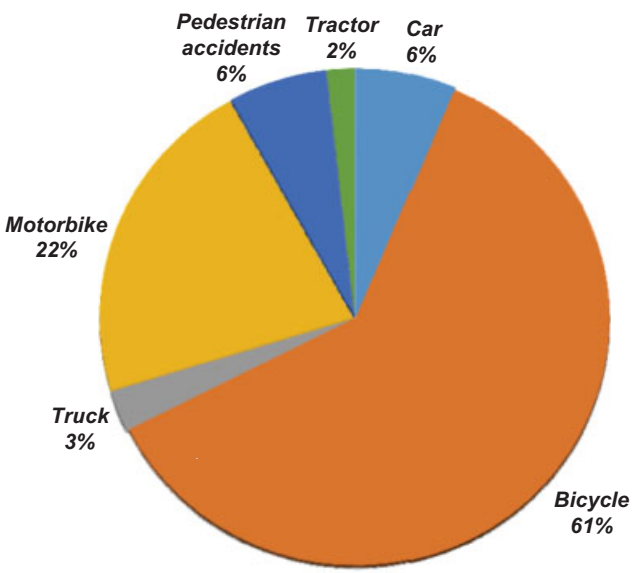

Fig. 5 Types of road accident causing trauma in the province of Brescia from 2010 to 2016.

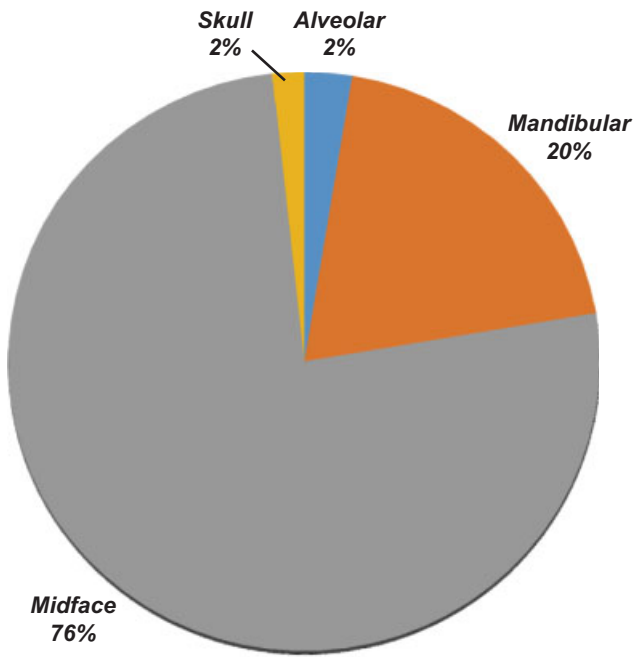

Fig. 6 Distribution of fracture sites in males.

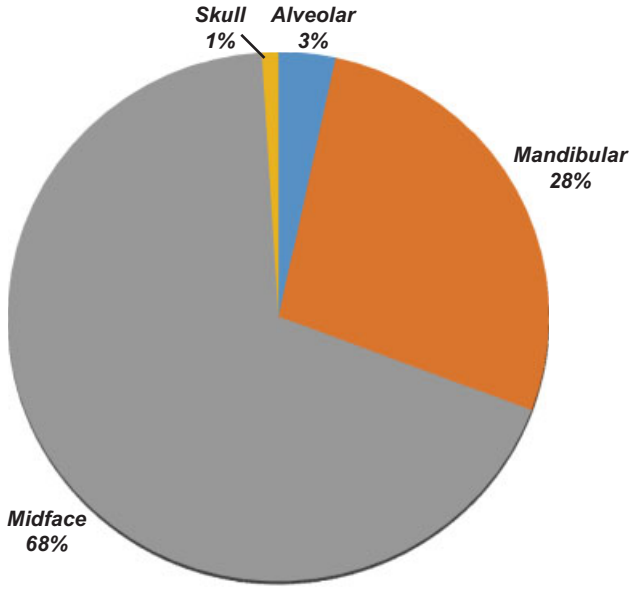

Fig. 7 Distribution of female fracture sites.

The 259 female patients had a total of 344 (68.25%) fractures in the middle third of the face, 138 (27.38%) mandibular fractures, 5 (1%) frontal fractures, and 17 (3.4%) alveolar fractures including avulsions of dental elements. (►**Fig. 7**)

Thus, jaw fractures were more common in females. In both sexes, the middle third of the face was the site most affected. In both sexes, the main type of fracture was orbitozygomatic, followed by fractures of the nose and orbit. (►**Figs. 8** and **9**)

In terms of jaw fractures, mandibular angle fractures were most common in males (22%) and condylar fractures were most common in females (26%; ►**Figs. 10** and **11**).

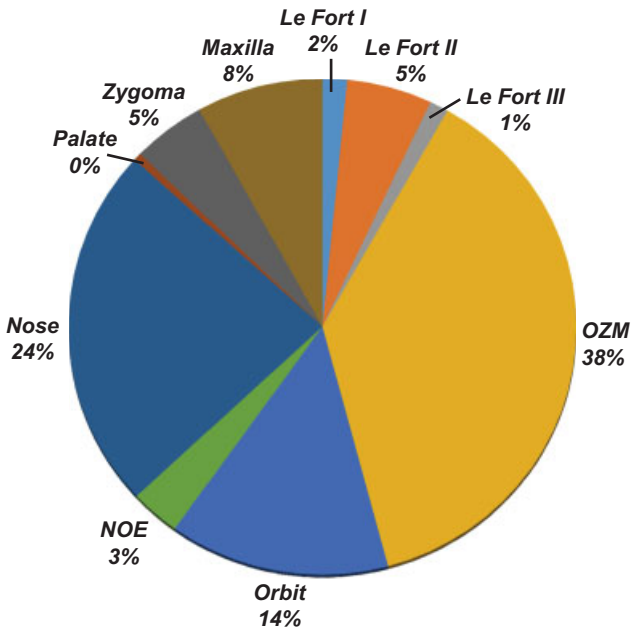

Fig. 8 Distribution of middle-third facial fractures in male.

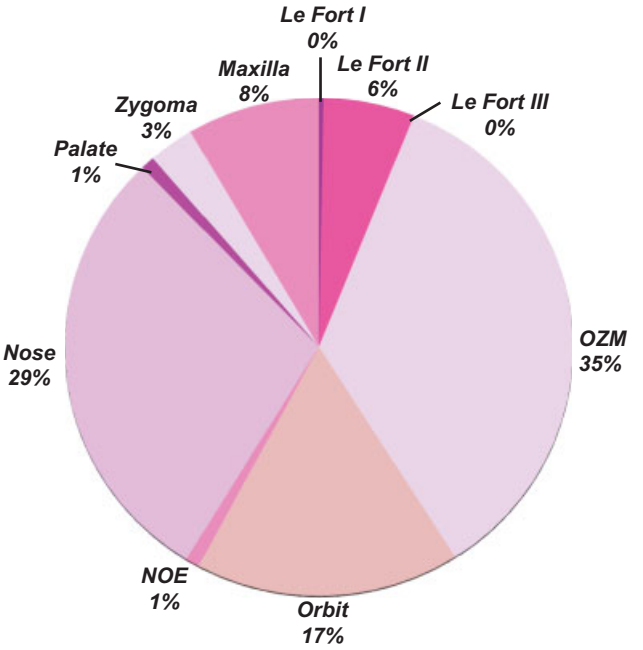

Fig. 9 Distribution of middle-third facial fractures in females.

The average FISS score, an index of trauma severity, was 2.07 (range: 1–18; SD: 1.88). The average was 2.073 in females and 2.068 in males, very similar. However, the maximum FISS score was 14 in females and 18 in males.

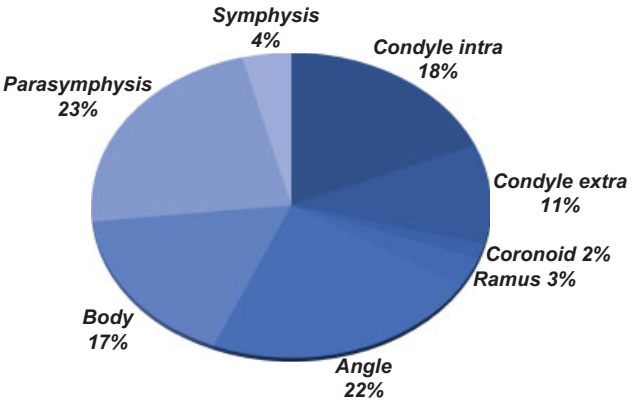

Fig. 10 Distribution of mandibular trauma in males.

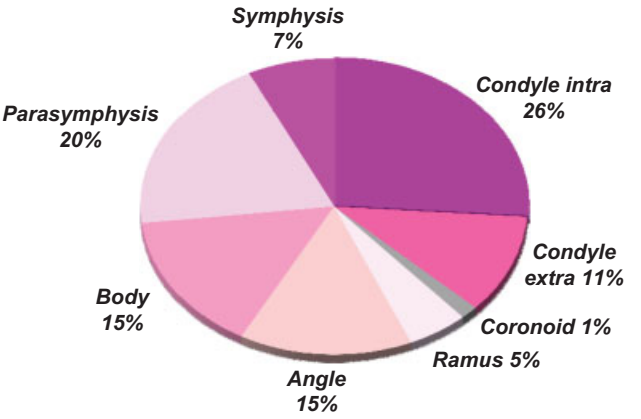

Fig. 11 Distribution of mandibular trauma in females.

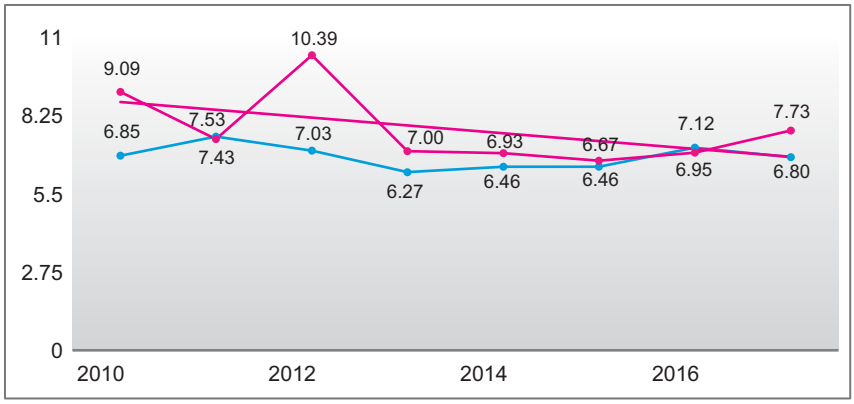

Fig. 12 Average duration of hospitalization per year. The blue line is for males, the pink for women, and the red line denotes the average for both sexes.

We evaluated the duration of hospitalization by both year and age group.

As shown in ►**Fig. 12** the annual duration of hospitalization decreased over the years for both males and females, perhaps reflecting improved clinical management.

►**Fig. 13** shows the duration of hospitalization by patient age; the duration increased with age. Elderly patients had higher FISS scores, indicating more severe facial traumas requiring longer hospitalization.

Discussion

The incidence, etiology, clinical presentation, and characteristics of facial fractures are influenced by sociodemographic, economic, and cultural factors[6–8]; we retrospectively analyzed epidemiological data from the province of Brescia, Italy. There tends to be more males than females with such injuries (the male to female ratio ranges from 2:1 to 8:1).[2,4,6,7,9] Our ratio was 3.87:1. Although a recent study found that the difference in injuries between the sexes has fallen over the past 30 years,[10] we treated significantly more males. The male/female ratio also changes according to the causes of fractures. Boffano et al[11] found that when the percentage of trauma caused by aggression is ≥40% or higher, males typically account for 80% of patients. In our study, the highest male to female ratios were noted in terms of work accidents (23.6:1) and sports accidents (18.7:1), being lowest for falls (1.96:1) and road accidents (2.6:1). Facial fractures are most common in those aged between 20 and 30 years,[2,4,6,12,13] but the average age of our patients was higher (40.7 years [46.6 and 39.2 years for males and females, respectively]). This is explained by increase in life expectancy, particularly in females, and by the increase in the age of the European population, associated with the increased activity of older subjects.

The etiology of facial trauma is directly correlated with the incidence, clinical presentation, and treatment of facial fractures,[6] and thus is of fundamental concern. Previous studies have found that road accidents, assaults, and falls are the main causes of trauma but differ depending on socioeconomic, cultural, and environmental factors.[14] Recent changes in etiology are evident in both developed and developing countries. In developed countries, the main cause of injury seems to be interpersonal aggression, but road accidents predominate in developing countries.[2,13,15] The main cause of facial trauma in our study was road accidents (252 patients), followed by aggression (182), sports accidents (178), and falls (169). Incidents at work and at home were less common (74 and 72, respectively)

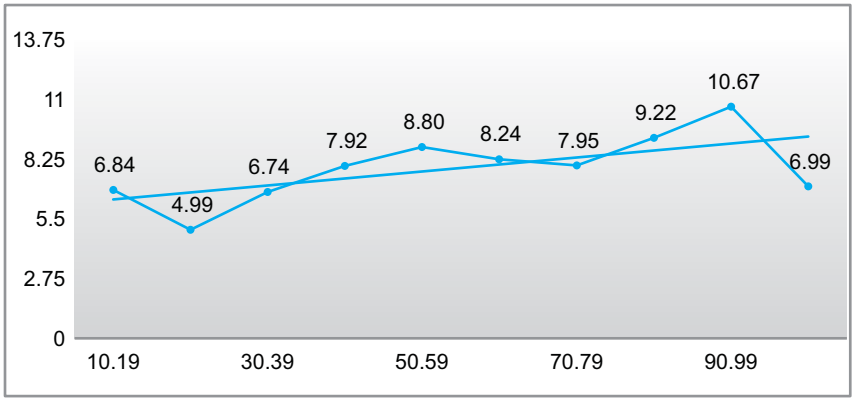

Fig. 13 Average duration of hospitalization by age group. Horizontal axis denotes the patients age group and the vertical axis is the number of days of hospitalization.

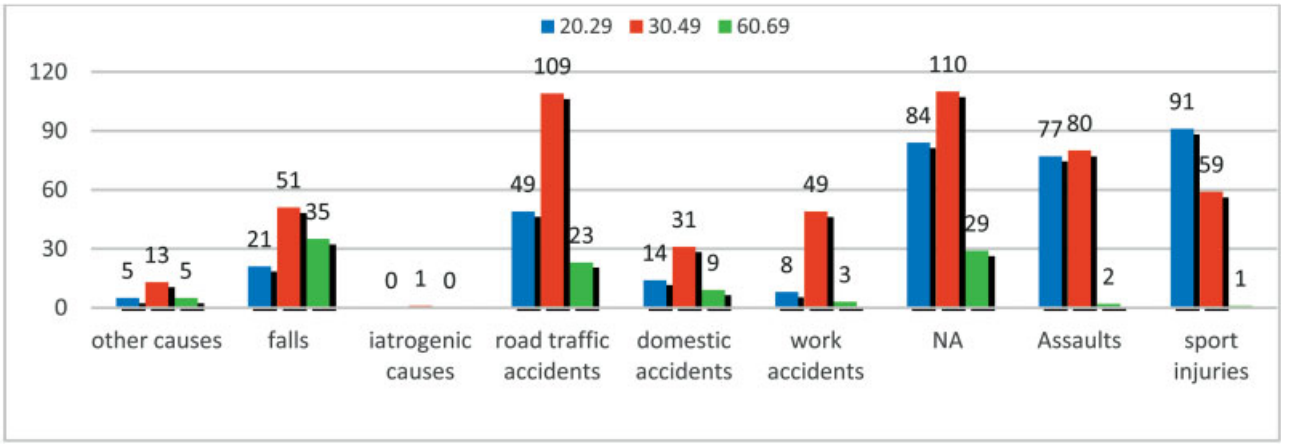

Fig. 14 Variation in etiology by age group.

We found that the causes of trauma varied by age, in line with Ungari et al.[16] Those aged between 20 and 29 years presented with sports injuries (91 cases) and injuries caused by aggression (77 cases). Those aged between 30 and 49 years had more road accidents (42 and 67 cases, respectively) with progressive decreases in sporting accidents and injuries caused by aggression. In those aged between 60 and 69 years, falls were the predominant causes of facial lesions (►**Fig. 14**).

We found that the largest increase over time was in injuries caused by falls (from 10 in 2010 to 38 in 2015). The average patient age of this group was 52.8 years which was higher than the average age (40.7 years). In addition, the average age of female patients was greater than that of male patients (54.57 and 51.88 years). As shown in ►**Fig. 15**, fall injuries peak in both males and females at 60 to 69 years old.

However, in males, a further peak is evident at 30 to 39 years. Finally, although males were more affected than females, the proportion of fall fractures was higher in females than in males. Thus, falls as causes of facial trauma are increasing significantly, mainly affecting females older than the typical facial fracture patient (who is young and male). Our results are consistent with those of Boffano et al,[11] who found that across centers, the patients $>$ 40 years of age are strongly associated with facial trauma. Hence, the aging of European populations may explain the progressive increase in facial fractures associated with falls. The increased risk of falling in older age is multifactorial in nature, associated with declines in cognitive and motor skills and movement disorders associated with loss of balance and strength.[17–21] In addition, the kinetic energy needed to inflict a bone lesion depends on bone density and structure.[22–24] These parameters define bone resistance and hence the fracture threshold, and are compromised by physiological changes associated with aging. Bone mass is reduced, particularly in postmenopausal females. Bones of the facial mass vary in terms of mineralization; the greatest fracture resistance is afforded by the frontal bone, followed by the jaw, zygomatic bone, maxillary bone, and nasal bones.[22–24] Thus, most fractures in older patients were in the middle third of the face, not the mandible (291 vs. 75). As esthetics are important surgical indications when treating fractures in the middle third of the face and are less important to older patients, it is possible that we underestimated the fracture rate in this group.

In one previous study, fractures caused by aggression increased over time from 20 to 35%.[25] We also found a continuous increase from 2013 to the end of the study, from 13 to 15.5%. We found no evidence of an increase in females (four to six cases per annum; two in 2012) but noted an increase in males from 18 cases in 2013 to 25 in 2016, usually in June (26 cases). For the female cases, 22% lacked data on the cause and 9% were defined as domestic accidents (almost twice that of men, 5%); injuries from aggression may thus have

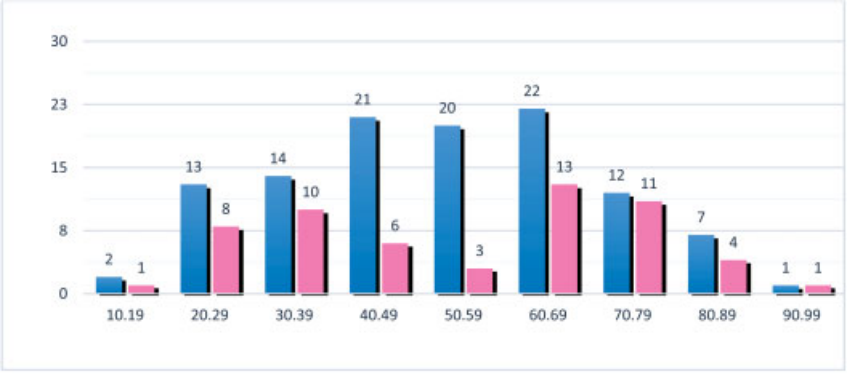

Fig. 15 Variation in fall etiology by sex and age. Blue is for males and pink is for women. Horizontal axis denotes the age group of the patients and the vertical axis is the number of falls.

been underestimated. More studies are required. Females are reluctant to report violence by husbands or partners.[26]

Traffic injuries are less common in Europe than before, associated with the mandatory use of safety belts and helmets, compliance with speed limits, an increased frequency of safety checks, and rules for safe driving. We treated 252 cases (approximately 20% of all cases) of facial trauma caused by road accidents, thus a lower proportion than that of another study[11] (42.7%), reflecting the decrease in accidents over time in developed countries. We found a rather stable trend toward fewer traffic injuries, most of which occurred in summer (bicycle accidents in 68 patients, motorbike accidents in 24, pedestrian accidents in 7, and car accidents in 7). Patients (both male and female) were predominantly aged, 40 to 49 years. Generally, road accidents are associated with more severe injuries[27]; this was the case in our study also, in which 41% of such patients had FISS scores ≥ 3. Such scores were associated with 24% work accidents, 23% assaults, 21% falls, 8% domestic accidents, and 8% sports accidents. Although airbags reduce morbidity and mortality, they cause new types of facial trauma.[28,29] Road accidents also cause soft tissue injuries. Nearly half of our cases (43%) had cuts > 10 cm in length requiring specialized suturing. In contrast, other studies have found that soft tissue lesions are more associated with interpersonal aggression and falls.[18]

A 5-year review of facial fractures by Haug et al[1] revealed a greater number of mandibular than zygomatic and maxillary fractures. We found that the most affected site was the middle third of the face (1,986 fractures, 76%), followed by the mandibular region (516 fractures, 19%), the oral cavity (68 fractures and avulsions, 3%), and the frontal region (45 fractures, 2%). This shows that sociodemographic factors affect the facial trauma pattern.

The zygomatic region was the most affected in those with orbitozygomatic fractures (both isolated and combined; 38%), particularly in males (710 fractures vs. 130 in females), as found in many studies.[30–32] More males than females are drivers, get into fights, and play contact sports such as soccer and basketball; moreover, males are more likely to use alcohol and drugs before driving.[16] Nevertheless, over the past 30 years, the incidence of facial trauma has increased in females, particularly those aged > 40 years. This is because the female role has changed; more females now drive, work outside of the home, and engage in sports involving physical contact.[33,34] Fractures of the zygomatic complex are frequently caused by road accidents, assaults, falls, and sporting accidents.[16] In our study, the major causes were road accidents (79 cases), falls (47), assaults (40), and sports incidents (36). One study[35] found that the most important risk factors for such fractures were not impacts by cars or trucks but rather collisions with static objects such as trees or telephone booths. Isolated zygomatic arch fractures are commonly attributable to lateral facial traumas impacting the zygomatic arc perpendicularly, thus injuries caused by aggression and sporting accidents.[35] Such fractures were more common in those aged between 30 and 39 years, and fractures of the orbitozygomatic complex were more common in those aged between 40 and 49 years, caused by traffic accidents.

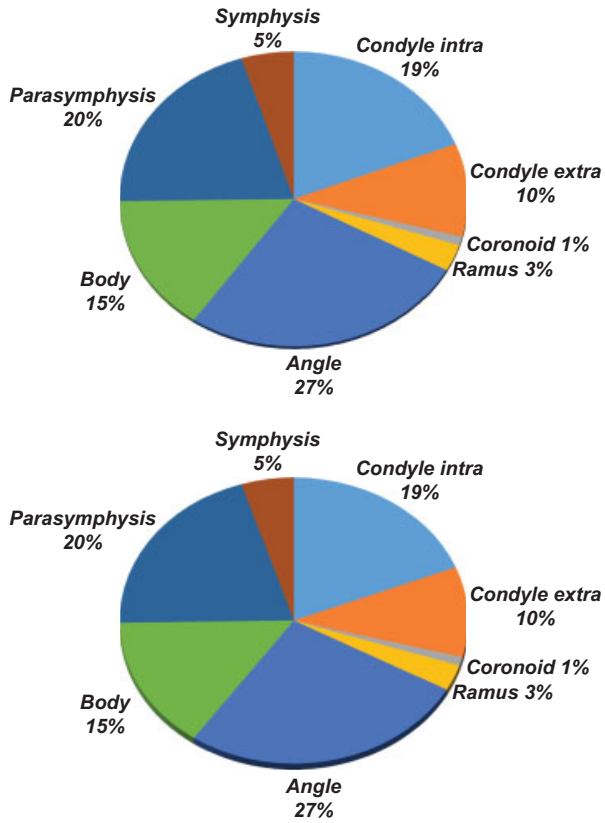

Fig. 16 Jaw locations for "low speed" fractures.

Regarding the mandible, the parasymphysis was the principally affected region of the lower jaw (22%) followed by the mandibular condyle (20%), mandibular angle (20%), mandibular body (16%), condylar neck (11%), symphysis (5%), upright branch (4%), and coronoid process (2%). Clear associations were evident between the mechanism and outcome of trauma and the cause and type of fracture.[36] The fractures can be divided into "high speed" (including road accident) fractures and "low speed" (interpersonal aggression, sports accident, and fall) fractures (►**Figs. 16** and **17**).

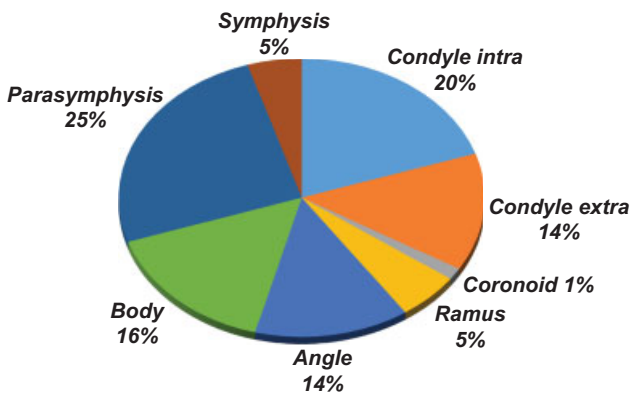

Fig. 17 Jaw locations for "high speed" fractures.

As others have reported,[36] we found a low prevalence of angular mandibular fractures (27%) and low velocity trauma at the level of the parasymphysis region (25%) and condyle (20%). Of the 347 cases of mandible fractures (516 fractures in total), 204 (59%) were single lesions and 143 (41%) were multiple lesions (double in 34% of cases, triple in 6.9%, and quadruple in 0.1%). Other studies[36] have reported higher proportions ($>$ 50%) of multiple mandibular fractures. Specific associations between mandibular fractures are evident; the fact that a particular type of fracture is often associated with another type of fracture is useful during diagnosis.[36] We found associations between fractures of the parasymphysis/symphysis and mandibular condyle in 21% of cases, and vice versa in 40% of cases. Force applied to the jaw that fractures the symphysis is then distributed in the direction of the condyles; the observed association is thus anatomically predictable.[36] As is true of the condyle, the mandibular branch is also frequently associated with the parasymphysis region, being contiguous in 52% of cases because force applied to the jaw is always transmitted further.[36]

Trauma scoring can help with prognosis.[37] The Abbreviated Injury Scale (AIS), based on anatomy, was proposed in 1971 and has been revised several times.[38] In 1974, Baker et al[39] showed that the severity and mortality caused by trauma are reflected by the sum of the squares of the three highest AIS scores for three different regions of the body (in both mono- and polytrauma cases), and proposed an Injury Severity Score (ISS); the AIS–ISS system has found global application as an index of survival. Mortality after facial trauma is low. However, irreversible facial damage (both esthetic and functional) can cause permanent psychological and physical disabilities.[40] Therefore, the AIS–ISS system, which is primarily an index of survival, is not useful when assessing the severity of facial trauma.[37] Several maxillofacial scoring systems are available but none are as widely used as the AIS–ISS system.[37] Catapano et al developed the FISS in 2010.[41] However, this system lacks detail and does not distinguish simple from complex fractures; no system that evaluates all types of facial fractures is yet available. Experience and expert judgment are essential. It is not yet known which scoring systems are most compatible with expert opinion.[37] We calculated the FISS score for each patient, which correlated with the duration of hospitalization; as the FISS score increased by 1 the average days of hospitalization increased by 12%. Thus, the FISS score can be used to assess trauma severity and predict prognosis.

Conclusion

In patients $<$ 40 years of age (much of the workforce), the major cause of mortality is traumatic injury of some type, associated with more loss of working years than cancer or vascular disease.[27]

Facial fractures are common in polytrauma patients as the head is very exposed. The incidence of facial injuries combined with greater trauma varies from 15 to 24% in England (Liverpool and London) to up to 34% in Washington (in a large database of 87,174 patients).[42–44] High-energy traumas of various causes trigger complex facial fractures affecting several regions. Treatment of such fractures is often associated with poor long term functional or esthetic outcomes, compromising social and emotional health. Long term disabilities may include epiphora, esthetic issues, and visual, olfactory, chewing, and respiratory problems.

In the time since facial trauma details were first computerized in Chicago in 1969, databases have allowed continuous monitoring of the causes and outcomes of various treatments. Data are now collected both regionally and nationally to monitor and improve protocols for prevention and treatment. Many epidemiological studies have been conducted locally, and thus are not necessarily representative of the entire population of the region, much less the national population. Many studies have been retrospective and associated with data loss, rendering extrapolation difficult. Some databases are incomplete, inaccurate, and/or nonstandardized. It is essential to establish a regional/supraregional database that yields the information needed to coherently and effectively plan how to prevent and treat maxillofacial trauma. This would lay a solid foundation. The data should be incorporated into a common European database such as that of the European Maxillofacial Trauma Project (EURMAT).[11]

Conflicts of Interest
None.

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