

## ORIGINAL ARTICLE

# Maxillofacial fractures: epidemiological analysis of a single-center experience

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## ABSTRACT

**BACKGROUND:** Maxillofacial fractures represent one of the principal cause of hospitalization in the entire world. The correct identification of type of fracture and of its site are important to provide a careful surgical management in order to minimize the functional and aesthetic consequences. Maxillofacial fractures present different etiological and epidemiological characteristics and a continuous analysis is important for monitoring ongoing changes.

**METHODS:** We present the experience of a single reference center of maxillofacial surgery, regarding 1022 patients treated during the decade 2005-2015, and analyze the etiology of trauma, the type of maxillofacial fracture and the treatment delivered, comparing to what is reported in the literature.

**RESULTS:** Our results suggest that male gender remains still the most frequent interested gender by fractures. Falls were the main cause of maxillofacial fractures, followed by violence and motor vehicle accidents in this series.

**CONCLUSIONS:** The internal rigid fixation is nowadays the preferred surgical treatment both for patient, because reduces the healing time with rapid functional recovery, both for surgeons because of its technical advantages.

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**KEY WORDS:** Maxillofacial injuries - Facial nerve injuries - Mandibular fractures - Internal fracture fixation.

Maxillofacial trauma is an important cause of hospitalization all over the world.<sup>1-27</sup> Facial fractures are not frequently life-threatening conditions, but the contemporary presence of impairment of the upper airways, brain, and/or spinal cord injury lesions might lead the patients to death. Therefore, maxillofacial fractures (MFs) require an early and appropriate diagnosis and management in order to avoid or reduce the long-term functional, aesthetics and also psychological consequences.<sup>3</sup>

Several etiological factors may determine MFs, such as road traffic accidents, interpersonal violence, falls, sport, and industrial accidents.<sup>4-6</sup> The epidemiology of facial fractures widely varies according to the assessed population, thus reflecting the social and demographic conditions.<sup>7-9</sup>

Therefore, the assessment of the epidemiological data of MFs may play an important role in the planning of preventive measures and effective treatment.<sup>10-25</sup>

The aim of the present epidemiological analysis was to evaluate the etiology, the distribution and the management of 1022 patients with MFs treated in the Department of Maxillofacial Surgery of University Hospital of the Novara in the decade 2005-2015.

## Materials and methods

On the whole, 1022 patients with MFs were treated in the Department of Maxillofacial Surgery from 2005 to 2015. Data including age, sex, etiology of trauma, fracture pattern and treatment modalities were collected. Etiology of

trauma included: motor vehicle accidents (MVAs); bicycle accidents; falls; violence; home accidents; work accidents; sport accidents; others (including events such as explosions, gunshots, or horse kick).

Fractures were classified as follows: mandibular fractures; nasal and septal fractures; isolated zygomatic fractures; isolated orbital fractures; orbital-malar-zygomatic complex fractures (COMZ); fractures of Le Fort I, II, III; isolated maxillary fractures not comprised in the classification of Le Fort; frontal or orbital-frontal fractures; naso-orbito-ethmoid complex fractures (NOE); fronto-naso-orbito-ethmoid complex fractures (FNOE); dentoalveolar fractures: multiple sites fracture.

The following sites of mandibular fractures were considered: symphysis and para-symphysis; body or angle; condyle; single or multiple mandibular fractures.

Different treatment options were chosen according to the type of trauma: rigid internal fixation (RIF) (osteosynthesis); maxillo-mandibular fixation (inter-maxillary blockage); titanium mesh; biological collagen bovine membrane (Tutopatch); simple reduction; dento-alveolar fixation; no surgical treatment.

Data were presented using descriptive analyses.

IRB approval exempt. We followed Helsinki declaration guidelines.

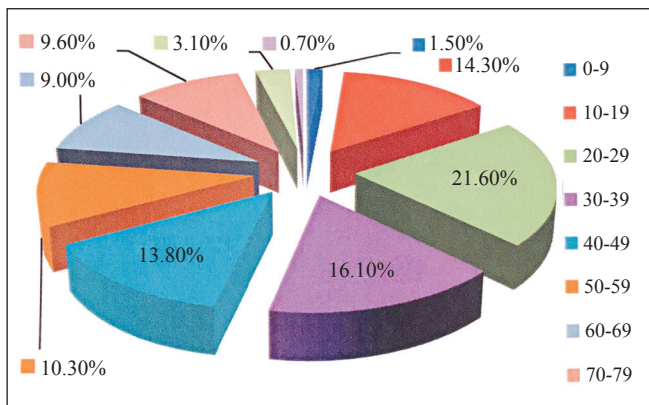


Figure 1.—Age distribution of maxillofacial fracture.

TABLE I.—Sex distribution of MFs according to age.

Gender	Age brackets									
	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	>90
Male	13	121	184	135	111	75	58	50	9	2
Female	2	25	37	30	30	30	34	48	23	5
Total	15	146	221	165	141	105	92	98	32	7
%	1.5%	14.3%	21.5%	16.2%	13.8%	10.3%	9.0%	9.6%	3.1%	0.7%

## Results

Within the study population, males outnumbered females (758 males, 74.2%; 264 females, 25.8%) with a male to female ratio of approximately 3:1. Mean age was 37.65±18.95 years for males and 51.3±23.2 years for females (range, 1-94).

MFs were most frequently observed in the 2<sup>nd</sup> decade (21.6%), followed by the 3<sup>rd</sup> decade of age group (14.2%) (Figure 1). In the male population, the 2<sup>nd</sup> and 3<sup>rd</sup> decades represented the most frequently involved patients, with respective percentages of 24.3% and 17.8% (Table I). Instead, as for females, MFs were distributed in a more homogeneous manner, with a slight predominance of the 7<sup>th</sup> decade group (18.2%). In both genders, mandibular fractures were the most common injuries (27.1%), followed by COMZ (25.8%) and nasal fractures (12.4%) (Table II).

## Etiology

Data about causes of injury are summarized in Figure 2. Falls were the most frequent mechanism of injury (N.=261, 25.5%), followed by violence (N.=185, 18.1%), MVAs (N.=179, 17.5%), and sport accidents (N.=150, 14.7%). MVAs were most frequent in the 2<sup>nd</sup> decade of age. Males were more frequently involved in violence (93.5%) and sport accidents (93.3%). Patients who reported sport-related facial injuries most commonly sustained an isolated fracture of mandibular angle (56%) or a nasal fracture (34.2%), whereas multifocal mandibular fractures were more commonly reported following aggressions or falls (69%). Among patients with multisite fractures, MVAs were the main cause (85 cases, 44.7%).

## Site and pattern of MFs

In our study population, 937 patients (91.68%) presented an isolated MF (Table II). In the remaining 85 patients (8.32%), multiple MFs were associated.

Most commonly, patients presented with mandibular fractures (277, 27.1%), followed by COMZ (N.=265, 25.9%), orbit (N.=148, 14.5%), nasal bone (N.=79, 7.7%),

TABLE II.—Distribution according to site and sex.

Site of fracture	Males	Females	Total	Percentage
Mandible	213	64	277	27.1%
Nasal bones	56	23	79	7.7%
Zygomatic arc	55	17	72	7.1%
Orbital walls	96	52	148	14.5%
COMZ	199	66	265	25.8%
Le Fort I	3	0	3	0.3%
Le Fort II	14	5	19	1.9%
Le Fort III	5	0	5	0.5%
FNOE	11	5	16	1.6%
NOE	4	0	4	0.4%
Frontal bone	25	3	28	2.7%
Dental-alveolar fractures	13	5	18	1.8%
Maxillary bone	2	1	3	0.3%
Multiple site	62	23	85	8.3%
All	758 (74.2%)	264 (25.8%)	1022	

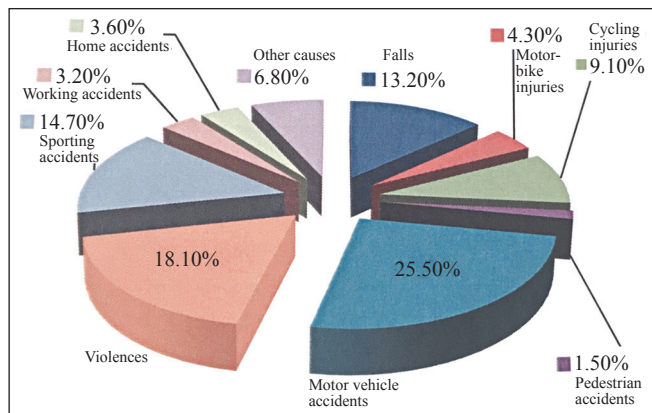


Figure 2.—Etiology of maxillofacial fractures.

and zygomatic arch fractures (N.=72, 7.1%), as reported in Table II. Among the 277 patients with mandibular fractures, there were 172 patients (62%) who presented an isolated mandibular fracture, 84 patients (30.4%) with bifocal mandibular fractures, and 21 patients (7.6%) with three or more fractures.

As for subsites of mandibular fractures, we identified 151 condylar fractures (37.4%), 110 angle fractures (27.4%), 52 body fractures (12.9%), and 90 parasymphiseal fracture (22.3%) (Table III). Condylar fractures were

TABLE III.—Localization of mandibular fractures.

Localization	Symphysis and parasymphysis	Body	Angle	Condyle	Total
Single	23	23	48	78	172
Bifocal	49	24	54	41	168
Multiple fractures	18	5	8	32	63
All	90	52	110	151	403

the most frequently observed fractures both in isolated (45.3%) and in multiple mandibular fractures (50.7%).

Orbital fractures were observed in 148 patients (14.5%), with the involvement of the floor in the 85% of cases. Isolated Le Fort fractures were noted in 27 patients (2.7%), frontal fractures in 28 patients (2.7%), and NOE fractures in the 2% of the study population (N.=20). Dentoalveolar fractures were 18 (1.8%).

Eighty-five patients reported two or more fractures and the most frequent association was between COMZ and nasal fractures (N.=25, 2.4%), orbital floor and nasal fractures (N.=19, 1.8%), and COMZ and mandibular fractures (N.=15, 1.4%) (Figure 3).

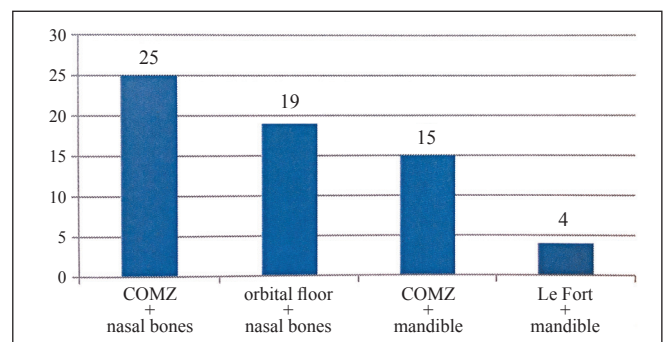


Figure 3.—Type of associations in multiple-site fractures.

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TABLE IV.—Treatment according to the site of fracture.

Parameters	Fixation with plates or screws	Titanium meshes	Bovine collagen membrane	Inter-maxillary block	Reduction	Dentoalveolar splints	Other	Conservative	Total
Parasymphysis	23	0	0	0	0	0	0	0	23 (2.3%)
Mandibular body	17	0	0	6	0	0	0	0	23 (2.3%)
Mandibular angle	43	0	0	2	0	0	2	1	48 (4.7%)
Condyle	49	0	0	23	0	0	2	5	79 (7.6%)
Bifocal mandibular	72	0	0	5	0	0	3	4	84 (8.2%)
Multi-focal mandibular	19	0	0	1	0	0	1	0	21 (2.1%)
Nasal bone	1	0	0	0	76	0	1	1	79 (7.7%)
Zygomatic arc	1	0	0	0	68	0	1	2	72 (7.1%)
Orbital floor	2	64	54	0	0	0	1	5	126 (12.4%)
Orbital lateral wall	1	0	0	0	0	0	0	4	5 (0.5%)
Orbital medial wall	0	3	5	0	0	0	0	6	14 (1.4%)
Orbital roof	0	0	1	0	0	0	0	2	3 (0.3%)
COMZ	251	0	0	0	2	0	2	10	265 (25.8%)
Le Fort I	3	0	0	0	0	0	0	0	3 (0.3%)
Le Fort II	17	0	0	0	1	0	0	0	18 (1.8%)
Le Fort III	5	0	0	0	0	0	0	0	5 (0.5%)
FNOE	14	0	1	0	0	0	1	0	16 (1.6%)
NOE	2	2	0	0	0	0	0	0	4 (0.4%)
Frontal	20	2	1	0	0	0	1	4	28 (2.7%)
Dentoalveolar	1	0	0	0	2	14	0	1	18 (1.8%)
Maxillary bone	2	0	0	0	0	0	0	1	3 (0.3%)
Associations	58	13	8	0	2	1	1	2	85 (8.3%)

**Management**

Most fractures needed surgical treatment (Table IV). About half of the patients (N.=600, 58.6%) were treated by rigid internal fixation (RIF) with plates and screws, followed by simple reduction in 151 patients (14.8%) who presented with isolated zygomatic or nasal fractures. Orbital floor fractures were treated by titanium mesh in 84 cases (8.2%) and by Tutopatch in 70 cases (6.9%). Most mandibular fractures (N.=222, 80.1%) were treated by rigid fixation with plates or screws, whereas 37 patients (3.6%) by maxillomandibular blockage.

In 48 patients (4.8%), no surgical treatment was performed because of severe systemic conditions contraindicating the operation.

**Discussion**

Fractures of the facial skeleton are frequently observed in patients affected by polytrauma following motor vehicle crashes, work accidents, sports accidents, or violence.<sup>8</sup>

The management of cranio-maxillofacial trauma includes treatment of facial bone fractures, dento-alveolar trauma, soft tissue injuries, as well as associated injuries, mainly of the head and neck.<sup>9</sup> Therefore, MFs require an early diagnosis and management in order to avoid or reduce the functional and aesthetic consequences.<sup>3</sup>

Etiological characteristics and the type of fractures significantly vary among the different geographic area, according to industrialization, diffusion of motorization, and relative safety policy.

This study assessed the epidemiology of MFs from a single institutional experience of 1022 patients over 10 years.<sup>20-27</sup> The results of this epidemiological study, in agreement with previously published data,<sup>10, 11</sup> highlight that young males in their twenties and thirties are the most commonly affected patients. As for females, the major incidence was observed in the 7<sup>th</sup> decade of age, in contrast with other reported data, where early decades were more affected.<sup>12</sup>

In our series, falls were the most common etiological factor (25.5%), followed by violence (18.1%), sport injuries (14.6%), and MVAs (13.2%). This result partly disagrees with previous articles, where MVAs were the most frequent cause of MFs.<sup>11, 13, 14</sup> MVAs, violence and falls are the leading causes of MFs worldwide: falls remain an important cause, especially in the older age groups;<sup>11, 15</sup> MVAs seem to have its maximum incidence in developing countries;<sup>16, 17</sup> finally in many Western countries, violence is becoming the predominant cause, overcoming MVAs.<sup>18</sup> The progressive decrease of MVAs (partly due to compulsory seat belts, the progressive introduction of airbags, and the new legislation against drunk driving) and the rise of violence have also been demonstrated in The Netherlands,

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USA, and UK.<sup>10, 19, 20</sup> Violence remains the most frequent cause in young males, likely due to the progressive increase of urban violence; instead, the frequency of work accidents (3.2%) seems to be progressively decreasing, probably thanks to the extensive use of personal protective equipment and the introduction of more restrictive occupational safety standards.

Condyle was the site most frequent subsite of mandibular fracture (37.5%), in agreement with an earlier study reported by Aksoy *et al.*<sup>21</sup> Another reported common MF fracture site includes the COMZ (25.9%), consistently with other studies.<sup>8, 11</sup>

In our study, rigid internal fixation (RIF) was the most common option of surgical treatment (58.6%), in agreement with the current literature.<sup>21-27</sup> This technique offers advantages both for surgeons and for the patients. It offers stable anatomic reduction of the fragments, it decreases the risk of post-operative displacement of the fractured fragments, it eliminates the need for maxillo-mandibular fixation in the postoperative period, and it allows for immediate recovery of function, thus reducing the consolidation time and healing period.<sup>21, 22</sup> Maxillo-mandibular fixation was only used in the 3.6% of our patients, especially for condylar fractures.<sup>26</sup>

### Limitations of the study

Limitations of the present study include the retrospective nature which gives selection or mis-classification biases. Another limitation was represented by the intervention of more surgeons which prevent the standardization of surgical treatment and the subsequent comparison among the various surgical modalities. However, this study provides an up to date of MFs epidemiology in a regional referral center.

### Conclusions

Epidemiological characteristics of MFs significantly vary among the Countries according to socio-economics condition, industrial development, and geographic context. Falls, violence and MVAs remain the principle causes, whereas the most frequently interested sites are the mandible, the COMZ, and the orbital floor. The type of accident seems to influence the site of fractures and their pattern. Surgical treatment remains the main management option and rigid internal fixation is the most frequent treatment used in order to reduce consolidation time and healing period.

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*Conflicts of interest.*—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript. Manuscript accepted: June 11, 2018. - Manuscript revised: May 28, 2018. - Manuscript received: April 26, 2018.

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