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Fractures Associated with Maxillofacial Trauma

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Abstract
Purpose: The aim of this study was to evaluate the number of maxillofacial fractures and their characteristics in trauma cases based on imaging investigations. *Materials and methods*: A retrospective, analytical, and observational study was performed. The research was conducted over a one-and-a-half-year period, between January 2017 to August 2018. The inclusion criteria were the presence of fracture on a radiological examination. The exclusion criteria were the absence of a maxillofacial fracture as well as patients with incomplete data. Age, gender, place of residence, diagnosis, concomitant fractures, the origin of trauma, imaging examinations, type of surgical therapy, and the number of days of hospitalization were assessed. *Results*: The data for this study originated from the results of observations of 139 patients hospitalized at the Oral and Maxillofacial Surgery Clinic. The sample's mean age was 35.53 years (SD: 17.45 years), and 86.3% of the subjects were males. Seventy-one cases (51.08%) were from urban areas. Fracture of the mandible (n=78; 56.1%) was the most common diagnosis, followed by fracture of the zygomatic bone (n=33; 23.74%). The most common associated fractures were fractures of the mandible in multiple locations (37.05%) and the LeFort fracture type (n=7, 5%). Interhuman violence was the most prevalent etiological cause (48.2%), followed by accidental falls (23%). For the duration of the patients' hospitalization, the mean occupancy rate was 3.31 days. Treatment comprised closed fracture reduction (41.2% of patients), followed by open reduction and immobilization in 29% of the subjects. *Conclusions*: Implementation of current treatment approaches and developing prevention strategies are essential for trauma outcomes and patients' quality of life.

Keywords: Maxillofacial trauma; Fracture; Cone-Beam Computed Tomography (CBCT); Treatment

Introduction

Oral and maxillofacial injuries comprise any physical trauma to the face. Craniofacial trauma is accompanied by varying degrees of soft and hard tissue disruption [1]. Assaults and falls are the most commonly (26.2%) reported etiology, although the causes are multifactorial [2]. Oral and maxillofacial injuries can range from isolated lesions affecting one or two bone components to widespread face lesions affecting the entire viscerocranium and affecting the soft tissues, teeth, and periodontium. Maxillofacial fractures may necessitate interdisciplinary management. In treatment strategies, along with a maxillofacial surgeon, it is necessary to involve a multidisciplinary team that includes a

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neurosurgeon [3], an ophthalmologist, and a plastic surgeon [4]. Healing of these complex injuries can result in morphological, functional, and physiognomic abnormalities, such as hypoaesthesia, infraorbital paraesthesia, or neuropathic pain symptoms [5], as well as facial deformities with potentially devastating psychological consequences [6,7,8]. Polytraumas are the most common cause of oral and maxillofacial injuries [9]. The relationship with cranioencephalic lesions suggests that the maxillofacial lesions might go undiagnosed or untreated, which might result in notable consequences [10]. The distribution of fractures depends on their mechanism of production. In general, the most common facial fracture occurs in the nasal bones [11]; nevertheless soft tissue, skeletal, and neurovascular injuries can occur [12]. The orbital floor is involved in fractures of the zygomatic complex [13]. The most common fractures in patients requiring hospitalization are the ones that involve the zygomatic bone, occurring in the zygomatic complex, about 40% [14], followed by more complex fractures such as LeFort, among them LeFort type 2 and type 3 fractures being significantly associated with the need for neurosurgical intervention [15].

Facial fractures in children are less common (10%-15% of all fractures) and less severe than in adults due to a less prominent jaw, less pneumatized sinuses, and increased bone elasticity [16]. Male subjects and patients from lower socioeconomic backgrounds were more likely to suffer face fractures due to violence [17]. Fractures of the mandibular condyle and the roof wall of the orbit [18], [19] are more common in young patients than in adults [20].

Imaging investigation has always played a critical role in the early diagnostic and therapy evaluation of these lesions [21]. Computed Tomography (CT) is considered the 'golden standard' method in the imaging assessment of oral and maxillofacial trauma [22]. Cone-beam computed tomography (CBCT) is a reliable alternative to computer tomography (CT), considering the lower radiation dose and high-resolution imaging on multiplanar reconstructions [23].

This study aimed to evaluate the number of maxillofacial fractures and their characteristics in trauma patients based on imaging investigations.

Material and Method

A retrospective, analytical, and observational study was performed. The research was conducted over a one-and-a-half-year period, between January 2017 to August 2018.

Selection and Description of Participants. The inclusion criteria were the presence of the imaging investigations [panoramic radiography, cone-beam computed tomography (CBCT), computed tomography (CT), or magnetic resonance imaging (MRI)], as well as a diagnosis of fracture caused by a maxillofacial trauma, with or without additional related fractures. The exclusion criteria were the absence of a maxillofacial fracture and patients with incomplete data.

Age, gender (male/female), place of residence (rural/urban), fracture location, imaging examinations, type of performed surgical therapy, and the number of hospitalization days (occupancy rate) were assessed. The acquired data was transferred to a database using Microsoft Excel software [24].

Statistics. The NCSS 10 software was used to perform the statistical and graphical analysis of the dataset, using a statistical significance threshold of 0.05 [25]. Descriptive statistics, along with Student t-tests and non-parametric Mann-Whitney test and correlation coefficients between age, gender, place of residence, trauma etiology, and hospitalization period were performed.

Results

The data for this study originated from the results of observations of 139 patients hospitalized at the Oral and Maxillofacial Surgery Clinic II Cluj-Napoca, Romania. The sample's mean age was 35.53 years, with a standard deviation (SD) of 17.45 years (range 4-87 years). The highest proportion of patients was found in the 20-45 years age group. Nineteen (13.7%) of the 139 patients were females, whilst the rest of 120 (86.3%) were males. Rural areas accounted for 68 cases (48.92% of the total 139 subjects), whereas urban areas were represented by 71 cases (51.08%). The average age in urban areas was 34.80 years, (SD±2.32 years), whereas the average age in rural areas was 36.09 years (SD± 1.96 years).

Cone-Beam Computed Tomography (CBCT) was the examination of choice for a more accurate diagnosis in patients with associated fractures, accounting for 43.5% of the total, followed by panoramic radiography at 19.5%, magnetic resonance imaging (MRI) at 10%, computed tomography (CT) at 3%, whilst the remaining subjects had recommendations for two or more examinations. Panoramic radiography associated with cone-beam computed tomography (CBCT) was the most common imaging examination (37%), followed by panoramic radiography and CT (16%). The least used imaging techniques were MRI (6%) and MRI associated with CT (4%).

Fracture of the mandible (n=78; 56.1%) was the most common diagnosis, followed by fracture of the zygomatic complex (n=33; 23.74%), fracture of the subcondylar region (n=15; 10.8%), fracture of the mandible angle (n=14; 10.1%), fracture of the nasal bones (n=11; 7.9%), fracture of the mandible body (n=12; 8.63%), and fracture of the orbital floor (n=9; 6.5%).

The most common associated fractures were fractures of the mandible in multiple locations (37.05%) and the LeFort fracture type (n=7.5%, Figure 1).

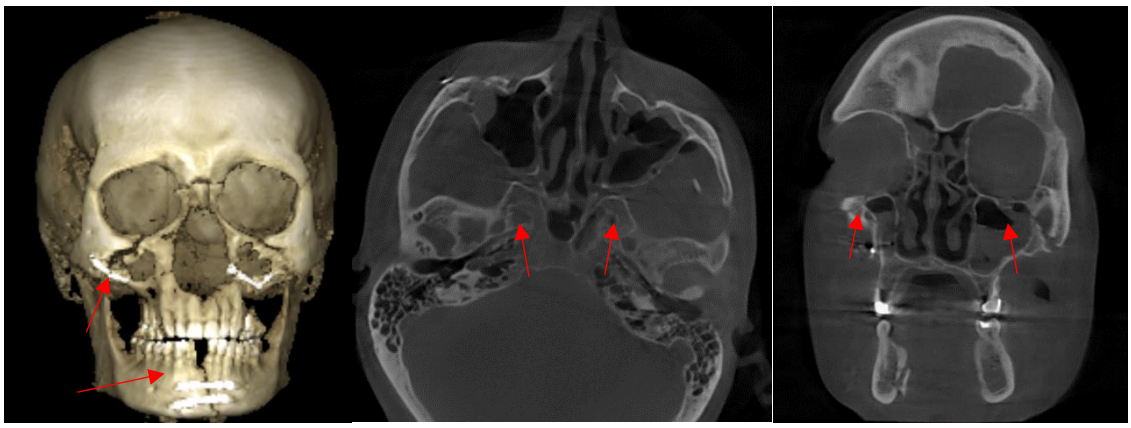


Figure 1. LeFort II and mandible fracture: **(a)** post-operative 3D CBCT projection of LeFort II fracture associated with median mandibular fracture. **(b)** CBCT axial image is able to identify the anterior and lateral wall fracture on both maxillary sinuses. **(c)** CBCT coronal image shows the bilateral zygomatic bone fracture and identifies the position of the orbital floor.

With 48.2 %, aggression was the most prevalent cause, followed by accidental falls (23%), road accidents (13.7%), play accidents and hoof kicks (4.3%), domestic accidents (2.2%), and work accidents (0.7%). On average, aggression victims were 35.3 years old, with a standard deviation of 14.9 years. The average age of individuals who had an accidental fall was 38.07 years, (SD= 19.76 years), of those who had a road accident 33.61 years, (SD= 19.12 years), of those who had a house accident of 50 years (SD=4.24 years), of those who had a play accident of 11.5 years (SD=5.32 years) and of those who suffered aggression was 35.38 years (SD=14.92 years) (p=0.02). We found a significant age difference between injured and abused individuals. With a large divergence from the normal distribution in the aggressors' group, the non-parametric Mann-Whitney test supported the statistical findings, with aggressed patients on average being 10 years younger than injured patients. The majority of the victims that suffered trauma caused by aggression were males (46.6% vs 2.3% females), caused by accidental falls (16% males vs 6.1% females), caused by road accidents (10.7% males vs 3.1% females), caused by play accidents (2.3% males vs 0.8% females), and by other etiologies (sports, work circumstances 9% males vs 3.1% females) p=0.04. In Figures 2 and 3, certain characteristics of CBCT of orbital fractures are depicted. To accurately assess the level of herniation of the orbital, intrasinusal soft tissue, successive CBCT slices individually obliquely coronal reconstructed were used to examine the orbital region and the maxillary sinus.

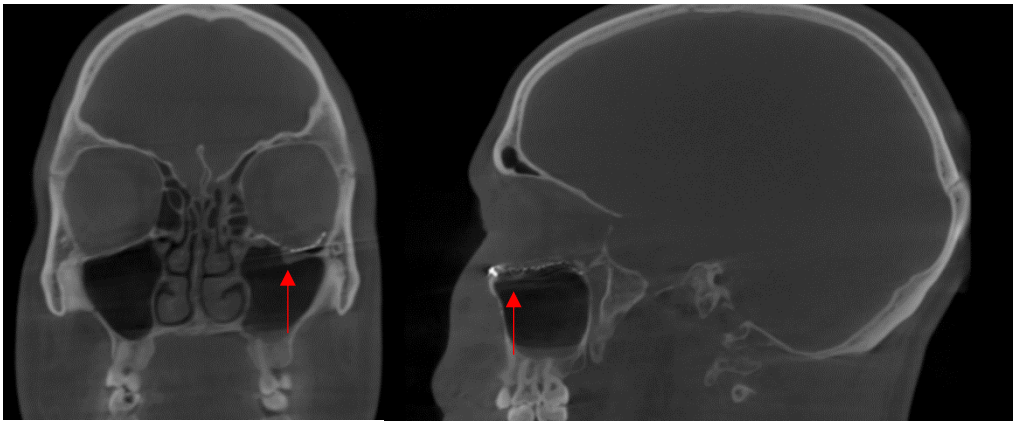
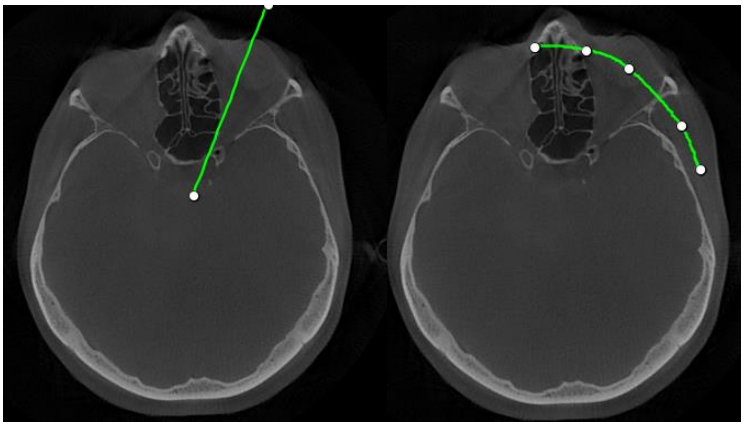


Figure 2. Left orbital fracture with surgical reconstruction of the orbital floor: **(a)** Individualized coronal oblique reconstructions of the orbit and left maxillary sinus using cone-beam computed tomography (CBCT). CBCT was able to provide information on the involved hard and soft tissues of the orbits. **(b)** CBCT sagittal view of the left orbital floor.



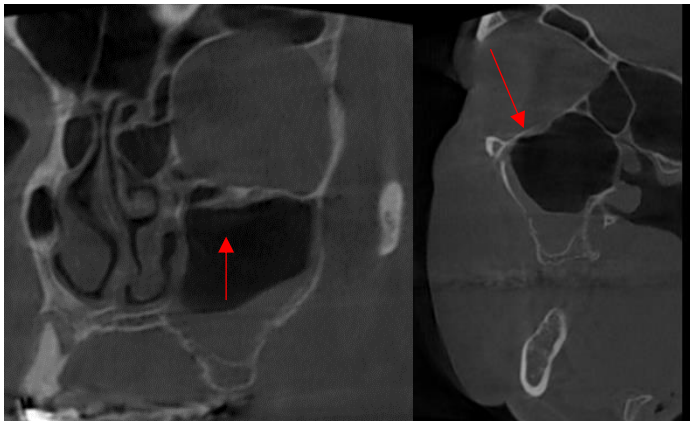


Figure 3. Individualized. coronal oblique **(a)** and sagittal oblique reconstructions **(b)** for the left orbit using CBCT. **(c)** Fracture of the infraorbital wall's internal third, with minor hemosinus and **(d)** intra sinus hernias of adipose tissue from the orbit.

For the duration of the patients' hospitalization, the mean occupancy rate was 3.3 days, with a standard deviation of 2.1 days. The shortest documented period was one day, and the longest was 15 days. Depending on the length of hospitalization, the highest concentration of patients was in the range of 2-3 days. Patients with concomitant fractures had significantly longer hospital admissions, ranging from 7 to 8 days, with a mean period of 5.7 days.

Regarding treatment, 41.2% of patients benefitted from closed fracture reduction, followed by open reduction and immobilization in 29%, open reduction and internal fixation in 20%, and open reduction and self-immobilization in 7.6%, whereas there were also patients who refused surgical treatment (2.2%).

Discussion

In this retrospective study, we have evaluated patients who were hospitalized between January 2017 to August 2018 at the Oral and Maxillofacial Surgery Clinic II Cluj-Napoca, Romania. We did not exclude any patients who had fractures caused by maxillofacial trauma because we emphasized knowing the number of associated fractures out of the overall number of fractures reported during this time. A total number of 139 patients were retrieved. The sample's mean age was 35.53, our data being consistent with those seen in the literature. Bogusiak and Arkuszewski, reported an average age of 37.1 years in 468 patients with zygomatic-maxillary complex fractures [26]. Other authors described ages between 30.5 years [27] and 44 years [28,29]. The most affected decade of age was reported as being between 20 and 29 years [30]. Gender distribution revealed a significantly higher involvement of men compared to women, a fact confirmed by our study, in which we encountered 86.3% males [31-35].

The average age in urban areas was of 34.80 years (SD: 2.32 years), while in rural areas it was an average age of 36.09 years (SD: 1.96 years).

In our study, assaults (48.2 %), unintentional falls (23%), and vehicle accidents were the most common causes of injuries resulting in associated fractures (13.7%). Assaults are the leading cause of these injuries, with road accidents coming in second or third, depending on the reporting authors. In the literature, the most common causes of maxillofacial fractures were reported as assaults (28.8%) and falls (23.9%) [34], which is in accordance with our results. Fractures of the zygoma were reported due to assault, vehicle collisions; falls, or sporting injuries [36].

Among etiology are cited: blunt impact to the face [37], level of education and living conditions [38], road traffic accidents [39], trauma [40], and alcohol abuse [41]. We found a significant age difference between injured and abused individuals with aggressed patients on average being 10 years younger than harmed patients. With a large divergence from the normal distribution in the aggressors' group, the non-parametric Mann-Whitney test supported the statistical findings.

In the accurate imaging evaluation of fractures and related fractures in the maxillofacial area, panoramic radiography and CBCT were most frequently used. On the other hand, panoramic radiography is more of a first-line radiological examination for mandibular fractures. Due to its advantages over other imaging examinations, CBCT is the most utilized for appropriate examination and diagnosis.

As it accurately depicts the anatomical regions, exposing previously undiscovered fractures by classic radiographs, CBCT is considered the choice method of assessing associated fractures of the maxillofacial area. Other used investigations included a CT scan of the cervical spine, especially in more severe cases and associated pathologies in this area. MRI has only been used in a few cases, with benefits in terms of visualization of orbital soft tissue lesions and intracranial complications.

Regarding treatment procedures, it has been reported that intraoperative imaging investigations show the utility of CBCT, allowing for non-invasive visualization of fracture reduction and a reduction in the needed number of incisions [42]. In terms of treatment choice, we could observe from our study that the most common surgical approach was the closed reduction technique of the fracture, as also was highlighted by Reiter et al., [43].

Regarding the duration of hospitalization, the majority of patients were hospitalized for between two and three days, concomitant fracture patients experienced noticeably longer hospital stays, ranging from 7 to 8 days with a mean duration of 5.7 days.

Strengths and Limitations

Our study tried to highlight the number of maxillofacial trauma cases during a period of 1.5 years and to report the demographic data of the subjects, maxillofacial trauma cause, evolution, and treatment modality. The practical utility of our results may encourage readers to prevent maxillofacial trauma by careful supervision of the possible etiological factors, and practitioners to enhance treatment modalities. Another study strength is the availability of high-quality CBCT images, that could aid in establishing a proper diagnosis of the fracture location, as well as the presence of associated fractures of the maxillofacial area. Not least, we have had also MRI images, which allowed better visualization of the soft-tissue involvement and their relationship with the fracture.

There are some limitations to our study. The first limitation refers to the fact that it was a retrospective study, with no patient follow-up. The reduced number of subjects, as well as the short observation period should be mentioned. Another important issue to consider is the data collection process, as patient charts had different investigation methods for maxillofacial trauma.

Implications for Practice and Future Research

Future prospective studies, with a large number of subjects, on a longer observation period are encouraged to gain evidence on the causes, evolution, and treatment possibilities of maxillofacial trauma. This way, clinicians could better monitor the management of maxillofacial trauma, its progression, and treatment possibilities, as well as the implications on patients' quality of life.

Conclusion

Our study showed that maxillofacial fractures occurred in young adults, especially in male subjects. In terms of etiology, aggression was the most encountered factor. CBCT scan of the skull is an effective method for maxillofacial fracture diagnosis. Our study underlines the importance of considering the demographic parameters of maxillofacial trauma and raises awareness about a critical issue regarding medical emergencies. According to the study, fractures are significant from both a demographic and socioeconomic perspective.

List of abbreviations

SD = standard deviation

CT = computed tomography
CBCT = cone-beam computed tomography
3D = three dimensional

Conflict of Interest

The authors declare that they have no conflict of interest.

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