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Retrospective Evaluation of Maxillofacial Fractures With Cone-Beam Computed Tomography

Emre Haylaz[1,a,*], Gediz Geduk[1,b], Çiğdem Şeker[1,c], Murat İçen[2,d]

[1]*Department of Oral and Maxillofacial Radiology, Zonguldak Bülent Ecevit University Faculty of Dentistry, Zonguldak, Türkiye*
[2]*Department of Oral and Maxillofacial Radiology, Nevşehir Hacı Bektaş Veli University, Nevşehir, Türkiye*
**Corresponding author*

Research Article

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ABSTRACT

Objectives: The aim of this study is to evaluate the distribution, localization, number, presence of displacement and radiological features of fractures in the maxillofacial region according to age and gender retrospectively by using Cone-Beam Computed Tomography (CBCT).

Methods: CBCT images taken from 84 patients who applied to Zonguldak Bülent Ecevit University Faculty of Dentistry, Oral and Maxillofacial Radiology Department between 2019 and 2021 due to trauma were retrospectively analyzed. Age, gender, fracture localization, and the presence of displacement in fractures were recorded. For statistical analysis, descriptive and frequency analyzes were applied to the entire patient group, while age and gender of the patients; Chi-square test was used when comparing with the fracture line and the fracture site.

Results: CBCT images of a total of 84 patients, 60 male and 24 female (M/F, 2.5/1) due to maxillofacial trauma, were examined. The number of 116 fracture lines occurring in various localizations due to different etiological reasons was detected radiologically. While displacement was observed in 73 of all fractures examined, displacement was not observed in the remaining 43 fracture lines. Fractures that occurred were most frequently detected in the mandibular angulus (22.61%:n=19). The least fractures were seen in the ramus of the mandible (3.57%; n=3) and coronoid process (3.57%; n=3).

Conclusions: Detection of the presence of fracture lines, their localization and displacement of fracture fragments through accurate radiographic techniques is important for the implementation of the necessary treatment procedures. In cases where the use of two-dimensional radiographs is insufficient, three-dimensional imaging methods such as CBCT should be preferred.

Keywords: Cone-Beam Computed Tomography, Fracture, Mandible, Diagnosis.

Maksillofasiyal Kırıkların Konik Işınlı Bilgisayarlı Tomografi ile Retrospektif Değerlendirilmesi

Süreç

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ÖZ

Amaç: Bu çalışmanın amacı maksillofasiyal bölgede meydana gelen fraktürlerin yaş ve cinsiyete göre dağılımlarını, lokalizasyonlarını, sayısını, deplasman varlığını, radyolojik özelliklerini Konik Işınlı Bilgisayarlı Tomografi (KIBT) ile retrospektif olarak değerlendirmektir.

Gereç ve Yöntem: Zonguldak Bülent Ecevit Üniversitesi Diş Hekimliği Fakültesi, Ağız Diş ve Çene Radyolojisi Anabilim Dalı'na 2019 ve 2021 yılları arasında travma nedeniyle başvuran 84 hastadan alınan KIBT görüntüleri retrospektif olarak incelenmiştir. Yaş, cinsiyet, fraktür lokalizasyonu, fraktürlerde deplasman varlığı kayıt altına alındı. İstatistiksel analiz için tüm hasta grubuna tanımlayıcı ve frekans analizleri uygulanırken, hastaların yaş ve cinsiyetlerini; fraktür hattı ve fraktür bölgesi ile karşılaştırırken ki-kare testi uygulandı.

Bulgular: 60 erkek 24 kadın hasta (E/K, 2,5/1) olmak üzere toplam 84 hastanın maksillofasiyal travma nedeniyle KIBT görüntüsü incelendi. Çalışmada incelenen hasta grubunun yaşları 6 ve 72 arasında değişmekte olup yaş ortalaması 33.17±1.48 olarak belirlendi. Farklı etiyolojik nedenlerden kaynaklı çeşitli lokalizasyonlarda meydana gelen 116 fraktür hattı sayısı radyolojik olarak tespit edildi. İncelenen tüm fraktürlerin 73'ünde deplasman izlenirken kalan 43 fraktür hattında deplasman görülmedi. Meydana gelen fraktürler en sık angulus mandibulada (%22,61:n=19) tespit edildi. En az fraktür mandibula ramus (%3,57; n=3) ve koronoid proseste (%3,57; n=3) görüldü.

Sonuçlar: Fraktür hatlarının varlığının, lokalizasyonlarının ve kırık parçalarının yer değişiminin doğru radyografik teknikler aracılığıyla tespit edilmesi, gerekli tedavi prosedürlerinin uygulanması açısından önem taşımaktadır. İki boyutlu radyografilerin kullanımının yetersiz kaldığı durumlarda KIBT gibi üç boyutlu görüntüleme yöntemleri tercih edilmelidir.

Anahtar Kelimeler: Konik Işınlı Bilgisayarlı Tomografi, Fraktür, Mandibula, Teşhis.

[a] *emrehylz03@gmail.com* *https://orcid.org/0000-0001-7330-9525*
[b] *gedizgeduk@gmail.com* *https://orcid.org/0000-0002-9650-2149*
[c] *cgdmdmrhn@gmail.com* *https://orcid.org/0000-0001-8984-1241*
[d] *drmuraticen@gmail.com* *https://orcid.org/0000-0002-2779-5646*

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Introduction

The maxillofacial region is one of the most traumatized areas in the human body. Its etiology and prevalence may vary in different populations. While traffic accidents are reported as the most common cause, home and work accidents, assault and sports injuries play a role in the etiology.[1,2] In the pediatric group, falls and traffic accidents are the most frequently reported causes.[3] Considering the etiological factors by gender, assault in men and traffic accidents in women have been reported as the most important factors in the literature.[4]

Fractures occurring in the maxillofacial region are most commonly seen in the nasal bones, while mandible fractures taking the second place.[5] Since the mandible has a distinct anatomical structure, it is more likely to be damaged due to trauma.[6] Maxillofacial trauma may cause serious clinical problems due to the characteristics of this anatomical region. As a result of fractures of the mandible, hypoesthesia, malocclusion, joint problems, damage to the teeth, and airway problems occur in the lower jaw.[7,8]

Fractures may occur isolated or may be more complex by affecting adjacent soft and hard tissues. Radiological imaging is essential for initial diagnosis and treatment planning.[9,10] The aim of radiological imaging is to show the fractures presence, localization, prevalence, displacement of fragments and foreign bodies of fractures caused by trauma, and also plays a major role in the recovery and maintenance period after treatment.[11]

In the diagnosis of maxillofacial trauma physical examination should be performed. Crepitation, tenderness, and occlusion disorders should be carefully evaluated on physical examination. Following the physical examination, conventional two-dimensional radiography and, if necessary, advanced three-dimensional imaging should be used.[12] Two-dimensional conventional radiographs are insufficient to determine the exact location and number of the fracture line in the visualization of complex fractures in the maxillofacial region. Computed Tomography (CT) is a commonly used imaging method in trauma patients. On the other hand, the use of CT in dentistry is limited due to the high dose and cost, the need for a larger area and limited accessibility. While Cone Beam Computed Tomography (CBCT) eliminates these problems, it also provides many advantages in the field of dentistry.[13-15]

Patients apply to dentistry clinics with many complaints and radiographic images are often needed to diagnose the problem. In cases where a complete diagnosis cannot be made with conventional rontgen techniques, it becomes necessary to resort to advanced imaging methods such as CBCT.[16]

The aim of this study is to determine the distribution of fractures occurring in the maxillofacial region by age and gender, localization, numbers, presence of displacement, and radiological features retrospectively with CBCT.

Material and Methods

CBCT (Veraviewapocs 3D R100 (J. Morita Corp., Kyoto, Japan)) images taken from 84 patients who applied to Zonguldak Bülent Ecevit University Faculty of Dentistry, Department of Oral and Maxillofacial Radiology between 2019 and 2021 due to trauma were retrospectively analyzed. Prior to the study, the approval of the Non-Interventional Clinical Research Ethics Committee of Zonguldak Bülent Ecevit University (2022/02 decision no.) was obtained.

In our study, factors such as age, gender, fracture localization were recorded from the patients who applied to the clinic. Fractures were classified as displaced and non-displaced. Single or multiple fracture lines were recorded. Fractures diagnosed in the study were modified according to the fracture classification of Harorlı et al. and classified as mandible, condyle and maxillofacial bone fractures.[17] Fractures in the mandible were subdivided according to their localization as coronoid process fractures, mandibular ramus, angulus, corpus, mandibular alveolar process, symphysis and parasymphysis fractures (Figure 1, 2, 3). Condyle fractures; condylar head-condylar neck and subcondylar region fractures were divided into two.[18] Maxillofacial fractures; they were grouped as maxillary alveolar process, pterygoid process, nasal bone fractures, maxillary sinus wall, zygoma and orbital fractures.[17]

Statistical Analysis

For statistical analysis, descriptive and frequency analyzes were applied to the entire patient group, while age and gender of the patients; Chi-square test was used when comparing with the fracture line and the fracture site. SPSS 22.0 Software Package Program (SPSS 22.0 Software Package Program, Inc. Chicago, IL, USA) was used as statistical software in the study. The p value was accepted as 0.05 in all tests.

Results

Between 2019 and 2021, CBCT images were obtained from 60 male and 24 female patients (M/F, 2.5/1) out of 84 patients due to maxillofacial trauma. Accordingly, the number of 116 fracture lines occurring in various localizations due to different etiological reasons were detected radiologically. Considering the gender distribution of the examined patient group, 80 (69%) of the fracture lines were detected in male patients and 36 (31%) in female patients. While displacement was observed in 73 of all fractures examined, displacement was not observed in the remaining 43 fracture lines.

While the mean age of the patient group examined in the study was determined as 33.17±1.48, the minimum age was 6 and the maximum age was 72. In order to compare gender, fracture site, localization, and the presence of displacements, patients were divided into three groups, aged 6-27, 28-50 and 51-72. The age range with the highest number of patients was the 28-50 age group with 38 patients.

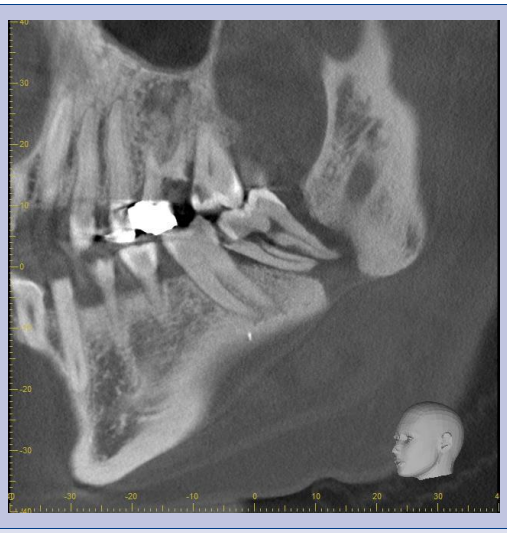

Figure 1. Vertical fracture line in the left mandible angulus region

Figure 2. Oblique fracture line in the left mandible symphysis region

Figure 3. Three-dimensional reconstruction of the symphysis fracture in Figure 2.

Age groups were divided into three groups at equal intervals in order to perform statistical tests. There were only 11 patients in the 51-72 age range, and there were 35 patients in the 6-27 age range. In the CBCT images of the patients examined, the mandible was the bone with the most fractures, with 61 fracture lines in 48 patients. Only mandibular bone fracture line is present in 30 patients. Mandible fractures were accompanied by condyle and maxillofacial region fractures in 18 patients.

Fracture lines in the maxillofacial bones were the second most common site. Fractures were detected in 54 patients in this region. While only maxillofacial bones were broken in 36 patients, fracture lines were seen in both mandibular and maxillofacial regions in 18 patients. Of the total fracture lines, 61 (52.6%) were detected in the mandibular region, 32 (27.6%) in the maxillofacial region, and 23 (19.8%) in the condyle region (Table 1). When the gender-fracture region and gender fracture line localization of the patients were compared with the chi-square test, no statistically significant results were found ($p>0.05$).

A statistically significant difference was found when the age ranges and fracture region were compared in the examined patient group. ($p<0.05$) (Table 1)

The localization of the fracture line are divided into 13 different regions, and their numbers along with the regions are given in Table 2.

The highest number of fracture lines (n=84) was observed in the mandible in all age groups. The most fracture lines were detected in the angulus (22.61%; n=20) region in the mandible. It is followed by the condylar head-condylar neck (21.42%;n=17), symphysis (14.28%; n=12), corpus (13.09%;n=11), parasymphysis (8.33%;n=7) in order of frequency, subcondylar area (7.14%;n=6) and mandibular alveolar process (5.95%;n=5). The regions with the least fractures in the mandible were found in the coronoid process (3.57%;n=3) and ramus (3.57%; n=3) (Table 1,2).

A total of 32 fracture lines were observed in the maxillofacial region. Fracture localizations were highest mostly detected in maxillary alveolar process (%62,5;n=20), maxillary sinus wall (%21,87;n=7) , zygoma (%9,37;n=3) and nasal bone (%6,25;n=2) respectively. No fracture lines were detected in the orbit (Table 1,2).

Discussion

The epidemiology of fractures occurring in the maxillofacial region; It has varied over time depending on the geography, socioeconomic status, cultural structure, lifestyle of the society and the level of development of the societies.19,20 Studies have linked the main causes of maxillofacial fractures to traffic accidents and interpersonal fights.[21]

The age range of 28-50 constitutes the age range with the highest number of fractures, with 38 patients in our study. This result shows the similarity of our study with the literature. As a result of the researchers, it has been reported that fractures are seen mostly between the ages of 20 and 50.

Table 1. Distribution of age group and number of fracture lines by region

Age Groups		Fracture Region			
		Mandible	Condyle	Maxillofacial	Total
Group 1 (6-27)	n	30	4	15	49
	%	61.2%	8.2%	30.6%	100.0%
Group 2 (28-50)	n	22	16	15	53
	%	41.5%	30.2%	28.3%	100.0%
Group 3 (51-72)	n	9	3	2	14
	%	64.3%	21.4%	14.3%	100.0%
Total	n	61	23	32	116
	%	52.6%	19.8%	27.6%	100.0%

Table 2. Distribution of detected fracture line localizations

Fracture Localizations	n	percent
Condyle Head- Condyle Neck	17	15.5%
Subcondylar Region	6	5.2%
Coronoid Process	3	2.6%
Ramus	3	2.6%
Angulus	20	16.4%
Corpus	11	9.5%
Mandible Alveolar Process	5	4.3%
Symphysis	12	10.3%
Parasymphysis	7	6.0%
Maxillary Alveolar Process	20	17.2%
Nasal Region	2	1.7%
Maxillary Sinus Wall	7	6.0%
Zygoma	3	2.6%
Orbit	-	0%
Total	116	100%

Table 3. Results of some studies on mandibular fractures

Authors	Year	Country	M/F	Age Range	Most Frequent	Least
Barde et al.[30]	2022	India	M >F	7-89 years	Parasymphysis (32%) Condylar Region (18%) Angulus (18%)	Coronoid Process (0.8%)
Kumar et al.[31]	2015	India	M >F	1-77 years	Parasymphysis (33%) Condylar Region (31%) Angulus (15%)	Coronoid Process (0.4%)
Devarakonda et al.[32]	2020	India	M >F	9 months to – 72 years	Parasymphysis (34.6%) Condylar Region (24.1%) Angulus (14.4%)	Coronoid Process (1.2%)
Buch et al.[33]	2016	USA	M >F	8 months to – 95 years	Angulus (34%) Condylar Region (27%) Alveolar Proses (12%)	Parasymphysis (3%)
Demirdover et al.[34]	2018	Turkey	M >F	1-86 years	Parasymphysis-symphysis (50.5%) Angulus- Ramus (27.6%) Corpus (19%)	Coronoid Process (1.8%)
AlHammad et al.[35]	2020	Saudi Arabia	M >F	15-34 years	Condylar Region (%25) Angulus (18%) Corpus (18%)	Coronoid Process (2%)
Hoşgör et al.[36]	2019	Turkey	M >F	7- 65 years	Angulus (%34.6) Parasymphysis (17.8%) Simfiz (11.8%)	Ramus (0.9%)
Lee et al[37]	2020	Korea	M >F	18-61 years	Symphysis-Parasymphysis (30.43%) Ramus (18.84%) Condylar Region (18.84%)	Corpus (1.44%)
Clevelan et al.[38]	2021	USA	M >F	0-18 years	Condylar Region (30.8%) Symphysis (27.9%) Angulus (25.6%)	Coronoid Process (1.4%)

M/F: Distribution of Gender Number (Male/Female)

Fractures are more likely to occur because this age group is more outdoors and more socially active.[22-25] Studies have shown that men are exposed to more maxillofacial trauma than women.[21,26,27] In another study conducted in Nigeria, it was stated that maxillofacial fractures are more common in women due to the fact that women have to work more in the external environment.[28] In our study, it was determined that the number of male was higher than female in all age groups, and this ratio was 2.5 / 1 in the total number of patients.

In our study, the bone with the highest number of fractures was found to be the mandible with 84 fractures. This result is consistent with Iida *et al.*'s conclusion that the mandible is one of the most frequently fractured facial bones due to its localization, protruding bone and lack of abutment point, although the etiologic causes are different.[29] In our study, we found the most common angulus fracture in the mandible. This was followed by the condyle head and neck, and then the symphysis region. The least fracture was detected in the coronoid process. The results found were similar the studies in the literature. Some studies in the literature are shown in Table 3.

In the radiographic images, the fracture lines are observed as sharp radiolucent lines within the anatomical borders of the mandibular structures.[39] Although there is a despite suspected fracture according to clinical examination findings, three-dimensional imaging techniques such as CT, CBCT and MRI should be used in the diagnosis of complicated fractures where the fracture line cannot be detected by two-dimensional imaging methods.[40,41] Three-dimensional imaging techniques allow imaging of the traumatized regions in sagittal, coronal, and axial planes, thus eliminating superpositions of adjacent structures. In this way, detailed radiographic examination of trauma regions, especially symphysis and condyle fractures without displacement, can be performed and diagnostic accuracy is increased.[42,43] It is reported that the sensitivity of CT in detecting mandible fractures is close to 100%.[44,45] However, it is argued that CBCT images are superior to CT images in the examination of hard tissues of the dental region.[46] CBCT also stands out with its higher spatial resolution, lower radiation dose, and less exposure to beam hardening artifact caused by metal structures. However, its inability to visualize soft tissues compared to CT poses a significant disadvantage for trauma patients.[42,47] According to these literatures, the use of CBCT in dentistry faculties, as in our study, appears to be a more practical method for the detection of fracture lines.

Conclusions

As a result of our study in accordance with the literature, fracture cases were mostly detected in young-adult individuals. This rate is higher in men than in women. In our study, it was determined that fractures mostly occur in the mandible. Detection of the presence of fracture lines, their localization and displacement of fracture fragments through accurate radiographic techniques is important for the implementation of the necessary treatment procedures. The use of two-dimensional radiographs is mostly limited to isolated fracture cases and minor traumas, so in cases where these radiographs are insufficient, three-dimensional imaging methods such as CBCT should be preferred for detailed information and definitive diagnosis.

Conflicts of Interest Statement

The authors have no conflicts of interests.

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