Anatomical Examination of Humerus, Radius and Ulna Fractures in 18-64 Year Old Individuals Applying to the Emergency Department

Acil Servise Başvuran 18-64 Yaş Arası Bireylerde Humerus, Radius ve Ulna Kırıklarının Anatomik Olarak İncelenmesi

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ABSTRACT

This study, it was aimed to anatomically examine the fractures of the humerus, radius, and ulna, which have a significant admission rate in emergency departments, and to explain the relationship between different fracture parameters. The anatomical distribution of humerus, radius, and ulna fractures in 239 patients who presented to Tokat Gaziosmanpaşa University Hospital between 2012 and 2018 were retrospectively investigated. Participants were between the ages of 18-64 years and were diagnosed with a fracture in only one bone. It has been found that fractures are more common in men and in the 18-44 age group ($p<0.01$). While falls are the most common cause of radius fractures, humerus fractures occur more frequently as due to traffic accidents ($p<0.01$). While distal fractures were more common in the radius, corpus fractures were more common in the humerus ($p<0.01$). Surgical intervention was more commonly performed for humeral fractures compared to radius fractures ($p<0.01$). Surgical intervention is more commonly observed in the treatment of corpus fractures, while it is less frequently observed in distal fractures ($p<0.01$). The distribution of upper extremity fractures of the humerus, radius, and ulna in the emergency department varies according to sex, age group, type of trauma, surgical intervention and anatomical localisation.

Keywords: Fracture; upper extremity; emergency department, anatomy

ÖZET

Bu çalışma kapsamında acil servislerde önemli bir başvuru oranına sahip olan humerus, radius ve ulna kırıklarının anatomik olarak incelenmesi ve farklı kırık parametreleri arasındaki ilişkinin açıklanması amaçlanmıştır. 2012-2018 yılları arasında Tokat Gaziosmanpaşa Üniversitesi Hastanesi'ne başvuran 239 hastada humerus, radius ve ulna kırıklarının anatomik dağılımı retrospektif olarak incelendi. Katılımcılar 18-64 yaş arasındaydı ve sadece bir kemikte kırık tanısı konmuştu. Kırıkların erkeklerde ve 18-44 yaş grubunda daha yaygın olduğu bulunmuştur ($p<0.01$). Radius kırıklarının en sık nedeni düşmeler iken, humerus kırıkları daha çok trafik kazaları sonucu meydana gelmektedir ($p<0.01$) Radius'ta distal kırıklar daha sık görülürken, humerus'ta korpus kırıkları daha sık görülmektedir ($p<0.01$). Cerrahi müdahale humerus kırıklarının tedavisinde yüksek iken radius kırıklarında daha düşüktü ($p<0.01$). Korpus kırıklarının tedavisinde cerrahi müdahale daha sık iken, distal kırıklarda cerrahi müdahale daha az sıklıkta bulundu ($p<0.01$). Humerus, radius ve ulna üst ekstremite kırıklarının acil servisteki dağılımı cinsiyet, yaş grubu, travma tipi, cerrahi girişim ve anatomik lokalizasyona göre değişmektedir.

Anahtar Kelimeler: Kırık; üst ekstremite; acil servis; anatomi

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INTRODUCTION

Emergency departments provide continuous medical and surgical care in life-threatening situations such as trauma and accidents[1]. As a result of improvements in healthcare systems and accelerated population growth, hospitals worldwide have faced challenges in providing emergency services [2]. Therefore, to ensure the provision of high-quality emergency services, it is essential to have detailed knowledge of the patient demographics in the region. The most common complaints in emergency department visits are related to otolaryngological issues, followed by orthopedic and traumatic conditions [1,3]. Orthopedic injuries, particularly extremity fractures, play a significant role. A 2015 study from the United States approximately 590,000 annual emergency department visits due to upper extremity fractures [4]. Among these fractures, upper extremity fractures of the radius are the most commonly observed, followed by fractures of the humerus and ulna [4-6]. Recent studies have increasingly focused on cases related to the hip and facial regions, particularly evaluating pediatric and geriatric age groups [7-9]. Studies with upper extremity fractures have either focused on a specific bone or assessed the upper extremity as a whole [5,7]. Besides these, fractures related to all body bones including particular age groups have been evaluated [10]. We could not identify a study specifically comparing humerus, radius, and ulna fractures in the adult age group within the upper extremity. Therefore, we aimed to anatomically examine the population aged 18 to 64 years presenting to the emergency department with humerus, radius, and ulna fractures.

MATERIALS AND METHODS

Research Design and Methodology

The population of this study consists of a total of 239 patients who presented to the emergency department of Tokat Gaziosmanpaşa University Hospital with fractures of the humerus, radius, and ulna between January 1, 2012, and December 31, 2018. Radiographic images and clinical data of the patients were retrospectively reviewed and analyzed.

Patients who met the following criteria were included in the study;

-Between the ages of 18 and 64.

-Having been diagnosed with a fracture in one of the humerus, radius, or ulna bones due to trauma.

-Diagnosed with a fracture in only one bone.

Patients with the following criteria were not included in the study;

-Under 18 years of age or 65 years of age or older.

-Diagnosis of fractures in more than one bone

- Diagnosed with metabolic bone disease

A total of 239 patients (M:153, F:86) were included in the study. Anterior-posterior and lateral radiographs of the upper extremity of the patients were analyzed through the hospital automated PACS system. Fractures of the humerus, radius and ulna in the upper extremity were identified and the results were listed in the Excel program. Gender, age, anatomical localization of the fracture, date of trauma, type of trauma, type of treatment were determined from the data of the patients in PACS and Enlil program. The mechanism of fractures in the patients was classified into two categories as traffic accidents and falls. Treatment modalities were investigated in two classes as whether there was surgical intervention or not. Anatomical localizations of the fractures were evaluated in three classes: proximal, corpus and distal. Patients were divided into two groups as weekdays and weekends according to the dates of presentation.

Power Analysis and Sample Size

To calculate the number of participants, a study of osteoporotic upper extremity

fractures was used for the calculation of the effect size, the mean incidence of fractures in patients by region was taken [11]. In this study, the effect size of the groups was 0.2957170 (Cohen's d). When effect size= 0.2957, alpha=0.05, power=0.95 were applied in G*power3.1.9.4 software, the total sample size was 148.

Statistical Analyses

SPSS 21.0 (SPSS, Chicago) package program was used to analyze the data in the study. Central and prevalence measures such as number, percentage, mean, standard deviation were used to create descriptive statistics, and Pearson Chi-square test and Fisher's exact test were used to determine the differences between categorical variables. Normality tests were not conducted as the data consisted solely of categorical variables. A p-value of less than 0.05 ($p < 0.05$) was considered statistically significant in this study.

Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki ("World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects," 2013) and informed consent was obtained before data collection. The study was approved by the Ethics Committee of Tokat Gaziosmanpaşa University (Document Number: 18-KAEK-146)."

Limitations of the Research

Since this study was designed retrospectively, it was not possible to directly examine factors such as current drug use, alcohol consumption and psychological status of individuals with fractures. However, to minimize this limitation, we took care to analyze in detail the information available in the records regarding the medical history of the fracture cases. Therefore, 239 patients were included in the study.

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RESULTS AND DISCUSSION

In the study, 239 patients with fractures were retrospectively examined: 153 males (64%) and 86 females (36%). Of the patients, 159 (66.5%) were in the 18-44 age group and 80 (33.5%) were in the 45-64 age group (Table 1).

Table 1. Sex and Age Distribution of Patients

Variables	Sex			
	Male		Female	
	n	%	n	%
Age Groups				
18-44 Age	114	74.5	45	52.3
45-64 Age	39	25.6	41	47.7

n: Number of cases. %: percentage of cases

When the fracture parameters were compared according to the sex of the patients, fractures were found more frequently in males in the 18-44 age group compared to females ($p<0.01$). When the time of trauma was compared according to the sex, fractures were found more frequently in males than females at the end of the week ($p<0.01$) (Table 2).

When the parameters seen in fractures were compared according to gender, no statistically significant result was found (p>0.05) (Table 2).

Table 2. Comparison of Parameters seen in Fractures According to Gender

Variables	Sex					χ^2	p**
	Male		Female				
	n	%	n	%	Total		
Age Groups							
18-44 Age	114	71.6	45	52.3	159	13	**<0.01**
45-64 Age	39	39.4	41	47.7	80		
Trauma Time							
Weekdays	89	%58.1	66	76.7	155	8.2	**<0.01**
Weekend	64	%41.9	20	33.3	84		
Bone							
Humerus	58	37.9	44	51.2	102		
Radius	75	49.0	30	34.9	105	4.8	0.09
Ulna	20	13.1	12	14.0	32		
Anatomical Location							
Proximal	33	21.5	21	24.4	54		
Corpus	39	25.4	29	33.8	68	2.8	0.23
Distal	81	53.1	36	41.8	117		

n: Number of cases, %: percentage of cases χ2: Chi square statistic, p: Significance Level

When the parameters seen in fractures were compared according to age groups, no statistically significant result was found (p>0.05) (Table 3).

Table 3. Comparison of Parameters in Fractures According to Age

Variables	Age Groups					χ2	p**
	18-44		45-64				
	n	%	n	%	Total		
Trauma Time							
Weekdays	101	63.5	53	66.2	154	0.1	0.91
Weekend	58	26.5	27	33.8	85		
Bone							
Humerus	59	32.7	43	43.7	102		
Radius	73	44.6	32	36.2	105	1.2	0.56
Ulna	22	22.7	10	21.1	32		
Surgical Intervention							
Yes	132	76.7	69	86.2	201	1.8	0.18
No	27	23.3	11	13.8	38		
Anatomical Location							
Proximal	33	21.5	21	24.4	54		
Corpus	39	25.4	29	33.8	68	2.8	0.23
Distal	81	53.1	36	41.8	117		

n: Number of cases, %: percentage of cases χ2: Chi square statistic, p: Significance Level

When the parameters seen in fractures were compared according to the type of trauma; radius fractures occurred more frequently as a result of falls, while humerus fractures were more frequently occurred as a result of traffic accidents (p<0.01). While more fractures were found in the distal part of the bone as a result of a fall, more fractures were found in the corpus part of the bone as a result of a traffic accident (p<0.01) (Table 4).

interventions in proximal fractures and less

Table 4. Comparison of Parameters in Fractures According to Type of Trauma

Variables	Trauma Type: Fall		Traffic accident		Total	χ2	p**
	n	%	n	%			
Sex							
Male	105	60.6	48	72.7	153	2.4	0.50
Female	68	39.4	18	27.3	86		
Age Groups							
18-44	112	67.4	47	71.2	159	0.4	0.90
45-64	61	35.3	19	28.8	80		
Trauma Time							
Weekdays	109	63.5	45	66.2	154	0.1	0.13
Weekend	64	26.5	21	33.8	85		
Bone							
Humerus	60	34.6	42	63.6	102		
Radius	87	50.2	18	27.2	105	17.4	**<0.01**
Ulna	26	15.2	6	9.2	32		
Surgical Intervention							
Yes	129	74.5	61	92.4	190	2.1	0.15
No	44	35.5	5	7.6	49		
Anatomical Location							
Proximal	37	21.3	17	25.7	54		
Corpus	38	21.9	30	45.4	68	17.4	**<0.01**
Distal	98	56.8	19	28.9	117		

n: Number of cases, %: percentage of cases χ2: Chi square statistic, p: Significance Level

When the occurrence of surgical intervention was compared with the fractured bone, surgical intervention occurred more frequently in the treatment of humerus fractures, while surgical intervention was less frequent in the treatment of radius fractures (p<0.01). There were more surgical interventions in distal fractures (p<0.01). When the anatomical location of the fracture was compared with the fractured bone, it was found that humeral fractures occurred more frequently in the corpus part, while radius fractures occurred more frequently in the distal part(p<0.01) (Table 5).

Table 5. Comparison of Fractures According to Surgical Intervention Status and Anatomical Localization

Variables	Surgical Intervention: No		Yes		χ2	p**
	n	%	n	%		
Bone						
Humerus	6	12.2	96	50.5	34.0	**<0.01**
Radius	40	81.6	65	34.2		
Ulna	3	6.2	29	15.3		
Total	49	100	190	100		
Anatomical Location						
Proximal	8	16.3	46	24.2		
Corpus	11	22.4	57	30	17.8	**<0.01**
Distal	30	61.3	87	45.8		
Total	49	100	190	100		

Variables	Anatomical Location: Proximal		Corpus		Distal		χ2	p**
	n	%	n	%	n	%		
Bone								
Humerus	29	53.7	41	60.2	32	27.3		
Radius	10	18.5	13	19.1	82	70.0	67.4	**<0.01**
Ulna	15	29.8	14	21.7	3	2.7		

n: Number of cases, %: percentage of cases χ2: Chi square statistic, p: Significance Level

When the fractures were evaluated according to the anatomical localisations of the bones, distal radius fractures, humerus corpus fractures and distal humerus fractures were frequently observed, respectively (Figure 1).

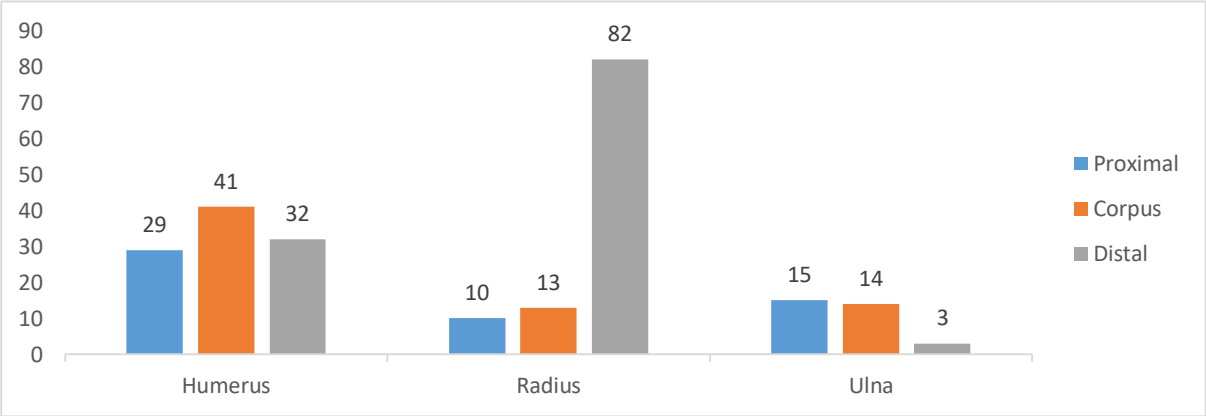

Figure 1. Comparison of the Anatomical Localizations of Humerus, Radius, and Ulna Fractures

Trauma, recognized as one of the leading causes of death among the young population and males, is a type of injury that poses a serious threat to public health [12]. Fractures are among the reasons for emergency department admissions, and upper extremity fractures account for 1.5% of all emergency department visits. It is estimated that 2-3 million people lose their workforce each year as a result of these injuries [13,14]. These results show that upper extremity fractures can have serious effects on both the emergency department and the national economy. In recent studies on fractures in our country and internationally, either studies involving specific bones such as pelvis, maxilla or studies involving the pediatric age group, however; to the best of our knowledge, no study has been conducted that anatomically examines upper extremity fractures in the adult age group [15-17]. Therefore, we aimed to show the anatomical relationship between the fractures of the humerus, radius and ulna in the adult age group.

When the fractures were examined by sex in the study, more fractures were detected in males than females. In an epidemiologic study conducted in Sweden in 2024, the sex distribution of ambulance services for patients admitted to the emergency department due to trauma was examined, and it was determined that men received ambulance services more frequently than women for trauma-related cases [12]. In a study of 266,324 upper extremity fractures conducted in Ontario in 2021, the distribution of fractures by sex was examined. It was found that fractures were generally distributed equally between men and women, regardless of the arm, forearm, or hand regions. However, when evaluated by anatomical region, distal radius fractures were more common in females, likely due to lower bone mineral density and biomechanical differences in fall-related impact absorption. Conversely, metacarpal and finger fractures were more common in males, which could be attributed to greater involvement in high-impact activities and differences in hand biomechanics, such as grip strength and punching forces [2]. These differences may be attributed to the physiological and biomechanical characteristics between males and females, which could influence the type and frequency of fractures in upper extremity injuries. In a study of upper extremity fractures admitted to the emergency department in the United States of America, the distribution of cases according to sex was examined and fractures were found to be more common in males. [14]. Factors such as the higher proportion of men working in high-risk

jobs and the frequency of participation in hazardous activities may contribute to the situation.

When fractures were evaluated according to age groups in our study, it was seen that fractures were more common in the 18-44 age group than in the 45-64 age group. In a study examining upper extremity fractures in the adult age group in the state of Minessedo in the United States of America, it was found that the highest number of upper extremity fractures was in the 18-34 age group. When the total number of fractures in the whole body was evaluated, it was found that more fractures were determined in individuals over 50 years of age [18]. In a study done in our country on upper extremity fractures, it was seen that fractures were more common in the age group of 18-50 years compared to the age group of 50 years and older [19]. In addition, there are studies that report a higher incidence of fractures in individuals over 50 years of age than in younger populations [20,21]. This may be due to the distribution of the number of individuals participating in the study and osteoporotic changes in bone structure at older age.

In our study, when fractures were evaluated according to trauma types, radius fractures were more common after a fall, while humerus fractures were more common after a traffic accident. In addition, radius fractures were found more frequently in the distal region of the bone, while humerus fractures were observed more frequently in the corpus region of the bone. In a study of forearm fractures in the Northern Region of Denmark between 2013 and 2017, it was reported that distal radius fractures were the most common fracture type and isolated ulna fractures were very rare. In the study is unnecessary falling was identified as the most common mechanism of injury, this was followed by sports activities and falls of 1 meter or more. [21]. In a study in the USA in 2022, it was found that humerus fractures were the most common fractures, followed by wrist fractures. [22]. In another study in Malawi, falls were the most common cause of radius fractures, followed by traffic accidents [23]. In another study in the United States, distal radius and ulna fractures were found to be the most common fracture types among upper extremity fractures admitted to the emergency department in both men and women. Focusing on humerus fractures, it was determined that proximal humerus fractures were the most common, followed by distal and corpus fractures. In this study, it was reported that fractures most frequently occurred as a result of falls, followed by firearm injuries and traffic[14]. In contrast, our study found that the most common humerus fractures were located in the corpus region, followed by distal and proximal fractures. This difference in anatomical distribution could be attributed to various factors. Our study primarily focused on individuals within the 18-44 age group, where high-energy trauma, particularly traffic accidents, plays a significant role in causing fractures. The humerus corpus may be more vulnerable to such high-impact injuries, which could explain the higher prevalence of fractures in this region in our study. Additionally, the larger surface area and the more central location of the corpus in the humerus may make it more susceptible to fractures in trauma situations compared to the proximal and distal regions. In another study in the USA, it was found that distal radius fractures were the most common type of fracture among upper extremity fractures according to age and sex, and proximal humerus fractures were found to be more common in individuals over 65 years of age compared to the younger population. [4]. In a study that epidemiologically examined humerus fractures, it was reported that humeral corpus fractures were most common in the 20-29 age group, and proximal humerus fractures were most common in general [24]. In low energy traumas such as falls, the use of the hand by individuals trying to balance their body weight may increase the risk of fracture in the distal part of the radius. On contrast, high-energy traumas such as traffic accidents may trigger fractures in long bones such as the humerus by creating a larger force effect on the bone. More frequent exposure to such high- and low-energy traumas in young adults

may lead to these differences in fracture distribution. In our study, surgical intervention was found to occur more frequently in the treatment of humeral fractures and less frequently in the treatment of radius fractures. In a study of national fracture records in Sweden, non-surgical methods were the preferred treatment for 74% of distal radius fractures [25]. In another study, 87% of distal radius fractures were treated non-surgically [26]. In a study examining the epidemiology of humeral fractures in Qatar, 72% of fractures were treated non-surgically. The reason for this is that the population of Qatar has more young and male population compared to the population of developed countries [27]. The stronger bones and higher healing potential of the younger and male population in Qatar may have facilitated the treatment of fractures without the need for surgical intervention in more severe cases. Additionally, the youth of individuals may have led to a greater use of reflexes that reduce the severity of trauma, further mitigating its impact. These factors may have contributed to the non-surgical treatment of most humerus fractures in Qatar. In a study investigating the epidemiology of humeral fractures in the USA, an increase in the incidence of surgical treatment of fractures was reported [28]. The preference for surgical intervention in humeral fractures may be due to the fact that these fractures are usually more complex and polytraumatised cases that may lead to functional loss. Radius fractures are usually caused by low energy trauma and are extra-articular in type [29]. As a conservative treatment option may be preferred in the management of this condition, non-surgical methods may be more commonly used in radius fractures.

CONCLUSIONS AND RECOMMENDATIONS

In this study, there is a significant difference in gender, age, type of trauma, anatomical localisation and frequency of surgical intervention in adult individuals with humerus, radius and ulna fractures. Limitations of the study may cause changes in these parameters and we believe that this reason can be revealed in more comprehensive studies with more participants. In this study, conditions such as alcoholic beverage use, use of any disease-related or addictive drugs, smoking, hunger/fasting status, psychological status (fatigue, stress, pressure) of the people who were admitted to the emergency department due to trauma and fractured humerus, radius, ulna bones of the upper extremity could not be evaluated. There is no information about the severity of trauma causing fracture in individuals. In cases of falls and traffic accidents, the severity of the trauma can significantly change the risk and severity of the injury. The limited sample size and the lack of proportional distribution of demographic data may affect the data. New studies can be planned in which these limitations are eliminated.

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