HUMERUS ÜZERİNDE ANATOMİK YAPILARIN MORFOMETRİK OLARAK İNCELENMESİ

Morphometric Investigation of Anatomic Structures on Humerus

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ÖZET

Giriş: Humerus; scapula, radius ve ulna arasında bulunan üst ekstremitenin en uzun ve kalın kemiğidir. Humarus üzerindeki anatomik yapılar morfoloji ve antropolojide cinsiyet ayrımını tespitte kullanılır.
Gereç ve yöntem: Bu çalışma 80 adet (56 sol, 24 sağ) humerus kuru kemik numunesinde 0,01 milimetre (mm) hassasiyetli dijital kumpas kullanılarak yapıldı. Kemik örneklerinde yaş ve cinsiyet ayrımı belli değildi. Humerus üzerinde 21 anatomik yapı ölçüldü.
Bulgular: Çalışmanın sonuçlarına göre humerusun maksimum uzunluğu solda ortalama 31.16±2.44 mm, sağda 29.85±3.08 mm'dir. Humerusun minimum gövde çapı solda 17.62 ±2.18 mm, sağda 17.84 ±1.82 mm, maksimum çapı solda 21.41 ±1.95mm ve sağda 21.29 ±1.77mmdir.
Sonuç: Humerus kemiğinin normal anatomik yapısını bilmek ve bu bölgedeki cerrahi prosedürleri ve protez uygulamalarını yönlendirmek için bu kemikteki anatomik yapıların ortalama değerlerini hesaplamak çok önemlidir.

Anahtar kelimeler: *Humerus; morfometri; kemik ölçümü*

ABSTRACT

Introduction: Humerus it is located between the scapula, radius and ulna bones and is the longest and thickest bone of the upper extremity. Anatomical structures on the humerus are used for sex discrimination in morphology and anthropology.
Materials and methods: This study was carried out using digital calipers with sensitivity of 0.01 millimeters (mm) on dry humerus bone specimens of 80 (56 left, 24 right). Age and sex were not differentiated in bone samples. 21 anatomical structures were measured on the humerus.
Results: According to the results of our study, the maximum length of the humerus mean 31.16 ± 2.44 mm on the left and 29.85 ± 3.08 mm on the right. Minimum body diameter (MinGW); 17,62 ± 2,18 mm on the left and 17,84 ± 1,82 mm on the right; Maximum body diameter (MaxWD); 21.41 ± 1.95 mm on the left and 21.29 ± 1.77 mm on the right.
Conclusion: It is very important to know the normal anatomical structure of the humerus bone and to calculate the average values of the anatomical structures on this bone in order to guide the surgical procedures and prosthesis applications in this region.

Keywords: *Humerus; morphometry; bone measurement*

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INTRODUCTION

Humerus, shoulder joint and elbow joint, such as the two important joints that we use in our daily life is involved in the structure (1,2).

There are two protrusions on the outside of the head of the humerus. Behind them and the larger one is called tuberculum major. The front and smaller one is called the tuberculum minus. At tuberculum greater, m. supraspinatus, m. infraspinatus and m. teres minor ends. These muscles are called rotator cuff muscles and are important for clinicians (3,4). The neck, which is located just below the tubercles, is called collum chirurgicum. Humerus fractures in these individuals are mostly called neck chirurgicum in this region (5).
Proximal humerus fractures constitute approximately 5% of the fractures admitted to the emergency department, but surgical options decrease in older ages (6).

Hemiarthroplasty is considered to be performed in patients with poor fracture dislocation, more than one anatomical neck fracture joint in patients with poor bone quality, unfit for osteosynthesis, poor health status, and low rehabilitation potential (7).

Since the humerus bone joins the structure of two important joints, articulatio humeri and articulatio cubiti, any pathology in this bone affects the quality of life of the individual (8). The characteristics of the anatomical structures on the humerus and the muscles attached to them, the structures passing through the formations here are also of great importance for surgeons (14, 16). This leads researchers to work on this bone. In addition, some bones that make up the human skeleton play an important role in sex determination from the skeleton (11-13). Nowadays, both forensic medicine and anthropological studies, sex determination is performed on bones by various methods. Morphometry is one of these methods. Morphometry; It is a study that determines the differences in shape and relationships with other variables (17). Chemical and mechanical factors cause the rapid deterioration of flat bones such as the skull and pelvis. Humerus, on the other hand, has been preferred by many researchers because of its durability (18).

In this study, detailed and precise measurements were made on the anatomical structures described above on the humerus bone and the results were recorded. Anatomical knowledge of the humerus will help orthopedists perform surgery in this region. Therefore, we have shown many morphometric measurements related to humerus in our article.

MATERIALS AND METHODS

This study was carried out on dry humeral bones of 80 (56 left, 24 right) by using digital caliper with sensitivity of 0.01 millimeter (mm). There was no age determination and gender discrimination on the bones. Data from both sides were measured symmetrically, and those with fractures, pathology and erosion of humerus bones were not included. Measurements were made by a single person in order to avoid differences related to the measurement person and the results were recorded. At the proximal end, trunk and distal end of the humerus; the maximum length of humerus, groove intertubercularis length, minimum trunk diameter, maximum trunk diameter, capitulum humeri, troclea humeri were measured on 21 anatomical structures.

Measured variables:
Variables measured at the proximal extremity of the humerus:
1. Maximum length of the humerus (MLH)
2. Transverse diameter of humeral head (TDHH)
3. Vertical diameter of the humeral head (VDHH)
4. Surgical neck circumference (SNC)
5. Groove intertubercularis length (SIL)
6. Groove intertubercularis width (SIW)
7. Groove intertubercularis depth (SID) (Figure 1,2)

Figure 1 and Figure 2. Front and back view of the humerus

The variables measured in the body of the humeri:
1. Tuberositas deltoidea circumference (TDC)
2. Minimum body diameter (MinBD)
3. Maximum body diameter (MaxBD) (Figure 3, 4)

Figure 3 and Figure 4. Head and body measurements of humerus

Variables measured at the distal extremity of humerus:
1. Capitulum humeri width (CHW)
2. Capitulum humeri length (CHL)
3.Trochlea humeri width (THW)
4. Trochlea humeri length (THL)
5. Ditch coronoidea width (FCW)
6. Ditch coronoidea depth (FCD)
7. Ditch radialis width (FRW)
8. Ditch radialis depth (FRD)
9. Ditch olecrani width (FOW)
10. Ditch olecrani depth (FOD)
11. Epicondylar width (EW) (Figure 5)

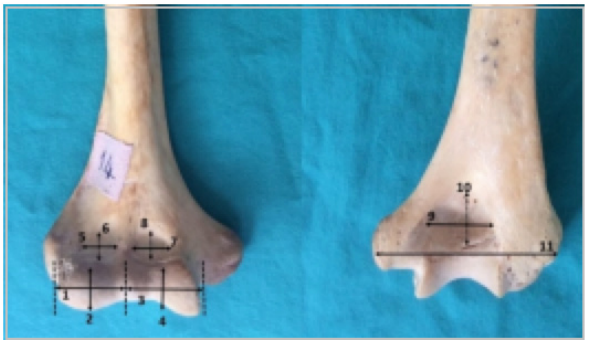

Figure 5. Measurements in the outer region of the humerus

Statistical analysis

The data of our study were transferred to computer by using SPSS (Statistical Package for Social Sciences) 15.0 program and descriptive statistical method was used.

The results obtained by morphometric measurements on the bones of the humerus are shown in the table (Table I).

Maximum length of the humerus (MLH). transverse diameter of the humerus head (TDHH). vertical diameter of the humerus head (VDHH). surgical neck circumference (SNC). Sulcus intertubercularis length (SIL). Sulcus intertubercularis width (SIW). Sulcus intertubercularis depth (SID). Tuberositas deltoidea circumference (TDC). Minimum body diameter (MinBD). Maximum body diameter (MaxBD). Capitulum humeri width (CHW). Capitulum humeri length (CHL). Trochlea humeri width (THW). Trochlea humeri length (THL)). Fossa coronoidea width (FCW). Fossa coronoidea depth (FCD). Fossa radialis width (FRW). Fossa radialis depth (FRD). Fossa olecrani width (FOW). Fossa olecrani depth (FOD). Epicondylar width (EW). N: Number of samples.

According to the results in the table MLH; mean 31.16 ± 2.44 mm on the left and 29.85 ± 3.08 mm on the right. SNC; mean 7.92 ± 0.81 mm on the left and 8.07 ± 0.82 mm on the right. SIL; mean 89.93 ± 9.22 mm on the left side and 87.02 ± 15.66 mm on the right side. SIW; the mean length of the left side was 6.72 ± 0.64 mm and the right side was 6.52 ± 1.00 mm. SID was measured as 3.79 ± 0.69 mm on the left side and 3.96 ± 1.09 mm on the right side. MinBD; on the left side, the mean value was 17.62 ± 2.18 mm and 17.84 ± 1.82 mm on the right side. MaxBD; 21.41 ± 1.95 mm on the left and 21.29 ± 1.77 mm on the right. EW; 58.21 ± 5.24 mm on the left and 57.07 ± 4.78 mm on the right.

Table I: Comparison of variables measured on left and right humerus bones.

Parameters	Minimum (mm)	Maximum (mm)	Average (mm)	Standard deviati
MLH	Left: 24.20 Right: 20.60	Left: 34.00 Right: 34.80	Left (N: 56): 31.16 Right (N: 24): 29.85	Left: ±2.44 Right: ±3.08
TDHH	Left: 31.42 Right: 31.85	Left: 46.62 Right: 48.58	Left (N: 56): 39.09 Right (N: 24): 39.22	Left: ±3.34 Right: ±4.08
VDHH	Left: 35.06 Right: 35.95	Left: 48.57 Right: 51.90	Left (N: 56): 43.10 Right (N: 24): 41.99	Left: ±3.84 Right: ±4.04
SNC	Left: 6.08 Right: 6.50	Left: 9.30 Right: 9.50	Left (N: 56): 7.92 Right (N: 24): 8.07	Left: ±0.81 Right Right: ±0.8
SIL	Left: 72.27 Right: 34.10	Left: 132.00 Right: 108.45	Left (N: 56): 89.93 Right (N: 24): 87.02	Left: ±9.22 Right: ±15.66
SIW	Left: 5.27 Right: 4.68	Left: 7.79 Right: 8.81	Left (N: 56): 6.72 Right (N: 24): 6.52	Left: ±0.64 Right: ±1.00
SID	Left: 2.69 Right: 2.23	Left: 5.43 Right: 7.00	Left (N: 56): 3.79 Right (N: 24): 3.96	Left: ±0.69 Right: ±1.09
TDC	Left: 5.40 Right: 5.07	Left: 8.00 Right: 17.71	Left (N: 56): 6.66 Right (N: 24): 7.12	Left: ±0.79 Right: ±2.38
MinBD	Left: 13.88 Right: 14	Left: 21.03 Right: 22.41	Left (N: 56): 17.62 Right (N: 24): 17.84	Left l: ±2.18 Right: ±1.82
MaxBD	Left: 17.60 Right: 18.03	Left: 25.38 Right: 25.51	Left (N: 56): 21.41 Right (N: 24): 21.29	Left: ±1.95 Right: ±1.77
CHW	Left: 15.36 Right: 16.63	Left: 24.55 Right: 24.30	Left (N: 56): 19.70 Right (N: 24): 19.63	Left l: ±2.09 Right: ±1.96
CHL	Left: 16.13 Right: 16.74	Left: 22.50 Right: 25.67	Left (N: 56): 19.85 Right (N: 24): 19.85	Left: ±1.76 Right: ±2.31
THW	Left: 17.45 Right: 18.10	Left: 24.88 Right: 27.49	Left (N: 56): 21.18 Right (N: 24): 21.46	Left: ±2.19 Right: ±2.45
THL	Left: 20.30 Right: 20.20	Left: 28.29 Right: 27.32	Left (N: 56): 24.15 Right (N: 24): 24.07	Left: ±2.21 Right: ±2.13
FCW	Left: 6.54 Right: 5.75	Left: 14.02 Right: 13.87	Left (N: 56): 9.80 Right (N: 24): 9.31	Left: ±1.13 Right: ±2.04
FCD	Left: 3.83 Right: 3.26	Left: 7.99 Right: 6.89	Left (N: 56): 5.35 Right (N: 24): 5.34	Left: ±1.05 Right: ±0.97
FRW	Left: 4.10 Right: 4.05	Left Left: 8.12 Right: 7.98	Left (N: 56): 6.31 Right (N: 24): 5.90	Left: ±0.75 Right: ±0.91

DISCUSSION

DeLude et al. (16) made morphometric measurements on dry humerus bones in order to determine whether there are geometric differences between the right and left humerus bone in the same individual. In their study, using an electromagnetic tracking system, 28 pairs measured 11 parameters on dry humerus bone morphologically. In the measurement results, only the height of the humerus head was significantly different between the right and left humerus of the same individual (P <005). There was no significant difference between the other parameters. In our study, humeral head lengths were measured as 35.06mm on the left, 35.95mm on the right, 48.57mm on the left humerus and 51.90mm on the right humerus. The differences between the measurements are due to the fact that the right and left humerus belong to different individuals.
Tellioğlu and Karakaş (17) performed morphometric measurements on the left adult humerus bones of both sexes in order to determine gender. In their study, they performed a total of 22 different measurements, eight measurements of the proximal end of the humerus, three measurements of the humerus body and eleven measurements of the distal end of the humerus. They found that the depth of the ditch radialis and the width of the trochlea humer were insignificant according to the test results. Other measurements were found to be significant. At the end of the study, the variables that can distinguish both sexes with high sensitivity and specificity; Transverse diameter of the humeral head, epicondylar width and minimum trunk diameter parameters were observed. In our study, the minimum epicondylar width was measured as 13.88 mm in the left humerus and 14 mm in the right humerus, and 21.03 in the right humerus as the widest one, and 21.41 mm in the right humerus.however, it was difficult to determine sex on dry bones in our study.

Frutos (18), in his study in Guatemala; a total of 118 adult left-sided humerus were used. As a result, all parameters measured were significantly higher in males than females. In discriminant analysis and gender analysis applications, it was seen that the vertical diameter of the humeral head was 95.5% between the univariate functions correctly. When discriminant analysis was applied to all variables, it was found that 98.2% of the humerus could be sexually accurate.

Mall et al. (19), in their study of sex determination with long bones of the upper extremity of the German population; measured maximum length of humerus, vertical diameter of humerus head and epicondylar width parameters. They found a significant difference between the measurements of women and men. In their studies using discriminant analysis using all measurements together, they classified 93.15% of the samples correctly. According to the results of discriminant analysis performed by using the variables individually, it was found that the highest separable measurement was the vertical diameter parameter of the humeral head with 90.41%.

Akman et al. (20) calculated the length of humerus segments in the Turkish population in order to compare them with the data of other countries for use in forensic and archaeological situations. For this purpose, one hundred twenty (56 left and 64 right side) male, adult, dry, Caucasian breed humerus bones were used to measure the morphometric properties of humerus segments. Six segments on the articular surface of the humerus (maximum height of the humerus (MHH)) and the distance between the articular segment of the humerus head and the more tuberculum majus (H1), the distance between the caput humeri and collum anatomicum (H2), the distance between the proximal and distal points of the ditch olecrani (H3).), the distal point of the ditch olecrani and the trochlea humeri distance (H4) and the proximal edge of the ditch olecrani and the proximal point of the trochlea humeri (H5)) measured with an electronic digital caliper. They found no significant difference in morphometric measurements between left and right samples. As a result of their study, they found that the length of humerus in the Turkish population was the same as the values of the other country population. In our study, the length of the humerus was measured as 24.20mm on the left and 20.00mm on the right and 34.00mm on the left and 34.80mm on the right. Values are close to each other. These results are similar to other studies.
Wafae et al. (21) conducted their studies on 50 adult dry humerus bone and did not discriminate on the bones. They measured the length, width and depth of groove

intertubecularis and humerus with a digital caliper and angle of groove intertubercularis with a goniometer. According to the results, they found the average length of groove intertubecularis to be 8.1 cm and found that this length corresponded to 25.2% of the length of the humerus. They measured a width of 10.1 mm at the midpoint of the groove intertubecularis and concluded that this width corresponded to 49.7% to 54.5% of the width of the humerus. They calculated the depth of groove intertubecularis to be 4.0 mm and found that this depth corresponded to 18.8% of the depth of the humerus. They measured the angle between the lips of the groove to 106°.

Rajan and KumAr (22) conducted their studies on 100 adult humerus bones (50 right and 50 left). They measured the medial and lateral wall length of groove inertubercularis and the width and depth of groove inertubercularis using a vernier caliper. They also examined the presence of supratubercular ridge in the humerus. According to measurement results, mean length of groove inertubercularis on the right side was 84.79 ± 5.84 mm and on the left side was 87.33 ± 6.40 mm; mean width of groove inertubercularis on the right side was 6.84 ± 1.01 mm and on the left side was 7.74 ± 1.96 mm; calculated the mean depth of groove inertubercularis on the right side as 4.21 ± 0.58 mm and 5.01 ± 1.05 mm on the left side. They calculated the mean length of the medial and lateral walls on the right side as 24.22 ± 1.02 mm and 32.05 ± 2.21 mm and on the left side as 23.31 ± 2.21 mm and 31.12 ± 0.24 mm, respectively. In this study, the presence of Meyer supratubercular ridge on the right side in 17% and on the left side in 14% of the humerus was detected. In our study, the length of groove intertubercularis was measured as 5.27mm on the left and 4.68mm on the right and 7.79mm on the left and 8.81mm on the right. Groove intertubercularis depth was 6.72mm on the left and 6.52mm on the right. Our study is similar to this study. Many measurements are made on dry bones in recent studies and these measurements are important surgical (23-26)

In conclusion, it was observed that the data of our study and the data obtained from other studies were close to each other. Thus, the data obtained from this study will be a reliable and guiding source for surgical interventions on the humerus, morphometric measurements and other studies to be performed in this direction. In addition, humeral fractures are common in emergency departments. In particular, knowing the grooves through which arteries and nerves pass and intervening accordingly will prevent potential complications. We hope that our study will be a reference to other studies and surgeons.

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