Turkish Journal of Medical Sciences

Volume 36 | Number 2 Article 2

1-1-2006

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Turk J Med Sci
36 (2006) 81-85

EXPERIMENTAL / LABORATORY STUDIES

The Morphometric Measurements of Humerus Segments

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Received: July 12, 2005

Abstract: The aim of the present study was to determine the lengths of humerus segments in the Turkish population and compare these with the data from other countries' population for use in forensic and archeological cases. For this purpose one hundred and twenty (56 left side and 64 right side) male adult dry Caucasians' humerus bones were taken 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 distances between the articular segment of the humeral head and the greater tuberosity (H1), caput humeri and collum anatomicum (H2), proximal and distal point of the fossa olecrani (H3), the distal point of the fossa olecrani and trochlea humeri (H4), and proximal edge of fossa olecrani and proximal point of trochlea humeri (H5)) were measured with an electronic digital caliper.

The distances in MHH, H1, H2, H3, H4 and H5 segments were found to be 307.1 ± 20.8 mm, 6.5 ± 1.6 mm, 41.0 ± 5.1 mm, 24.2 ± 2, mm, 20.0 ± 2.2 mm and 23.9 ± 2.6 mm, on the right side of humerus and 304.8 ± 18.9 mm, 6.6 ± 1.3 mm, 40.9 ± 3.9 mm, 40.6 ± 3.3 mm, 19.7 ± 2.5 mm and 39.7 ± 3.4 mm on the left side of humerus, respectively. No significant difference was found in the morphometric measurements between left and right side specimens.

In conclusion, our measurements on the humerus have demonstrated that the length of humerus in Turkish population is similar to that of other country population values.

Key Words: Humerus, anatomy, morphometry, anthropometry

Introduction

Estimating of stature from bones play an important role in identifying unknown bodies, parts of bodies or skeletal remains. Anthropometric techniques have been commonly used to estimate stature and bone length from the skeletal remains and unknown body parts by anthropologists, medical scientists and anatomists for over a hundred years (1-3). Knowing the mean values of humerus segments is very important for anatomic and forensic science and helps the investigator to define the identity of a skeleton. Also, these data give evidences to indicate the characteristic features of a population for archaelogical materials (4- 6).

The estimation of bone length from incomplete long bones was firstly identified by Müller. She defined 5 segments for the humerus using the margins of articular surfaces and key points of muscle attachment (6). Knowing these segment measurements which are defined, is very helpful for determining the humerus length (7).

Therefore, the study was made to determine the mean values of humerus segments in our population and compare the findings with other populations to assist in forensic and archeological cases.

Material and Methods

The bones were collected from Cukurova University, Department of Anatomy. Different morphometric measurements from 120 (64 right, 56 left) adult male Caucasians' humerus (aged 30-60 years) were taken by the authors. The lengths of the segments were measured with an electronic digital caliper in milimeters. Individuals with non-pathological humerus boneswere included in the study. Six measurements were taken following the longitudinal axis of the humerus shown in Figure and were as follows:

A-F: Maximum height of the humerus, the distance between the most proximal point of the caput humeri to the most distal point of the trochlea humeri (MHH) (Figure).

A-B: The distance between the most proximal point of the articular segment of the humeral head to the most proximal point of the greater tuberosity (H1) (Figure).

A-C: The distance between the most proximal point of the caput humeri and collum anatomicum (H2) (Figure).

D-E: The distance between the most distal point and the most proximal point along the edge of the fossa olecrani (H3) (Figure).

E-F: The distance between the most distal point of the fossa olecrani and trochlea humeri (H4) (Figure).

D-F: The distance between along the proximal edge of the fossa olecrani and the most proximal point of trochlea humeri (H5) (Figure).

The program SPSS 9.0 was used in the statistical evaluation of measurement results. From these measurements mean and standart deviations were calculated.

Figure . MHH: Maximum height of the humerus, the distance between the most proximal point of the caput humeri to the most distal point of the trochlea humeri (A-F), H1: The distance between the most proximal point of the articular segment of the humeral head and the most proximal point of the greater tuberosity (A-B), H2: The distance between the most proximal point of the caput humeri and collum anatomicum (A-C), H3: The distance between the most distal point and the most proximal point along the edge of the fossa olecrani (D-E), H4: The distance between the most distal point of the fossa olecrani and trochlea humeri (E-F), H5: The distance between the proximal edge of the fossa olecrani and the most proximal point of trochlea humeri (D-F).

Results

A total of 120 (64 right, 56 left) adult male humerus bones were included in this study with an age ranging from 30-60 years. To determine the mean values of humerus segments, descriptive statistics were used. With the morphometric evaluation of the humerus, the distances from the caput humeri to collum anatomicum, greater tuberosity and trochlea humeri were found to be 41.0 ± 5.1 mm, 6.5 ± 1.6 mm, 307.1 ± 20.8 mm on the right humerus and 40.9 ± 3.9 mm, 6.6 ± 1.3 mm, 304.8 ± 18.9 mm on the left humerus respectively. The other two dimensions were from the proximal margin of olecranon fossa to distal margin of olecranon fossa and trochlea were 24.2 ± 2, mm and 40.6 ± 3.3 mm on the right side and 23.9 ± 2.6 mm, 39.7 ± 3.4 mm on the left side, respectively. The last measurement, between distal margin of olecranon fossa and trochlea was 20.0 ± 2.2 mm on the right side and 19.7 ± 2.5 mm on the left side. No significant difference was found between left and right sides of specimens in all parameters.

The mean and standard deviation (SD) for humerus are shown in the Table.

Table. Morphometric Measurements of The Humerus
n= 64 (right), 56 (left)

Measurement	Right/Left	Mean ± Standard deviation (mm)
MHH	Right	307.1 ± 20.8
	Left	304.8 ± 18.9
H1	Right	6.5 ± 1.6
	Left	6.6 ± 1.3
H2	Right	41.0 ± 5.1
	Left	40.9 ± 3.9
H3	Right	24.2 ± 2.0
	Left	23.9 ± 2.6
H4	Right	20.0 ± 2.2
	Left	19.7 ± 2.5
H5	Right	40.6 ± 3.3
	Left	39.7 ± 3.4

MHH: Maximum height of the humerus, the distance between the most proximal point of the caput humeri to the most distal point of the trochlea humeri, H1: The distance between the most proximal point of the articular segment of the humeral head to the most proximal point of the greater tuberosity, H2: The distance between the most proximal point of the caput humeri and collum anatomicum, H3: The distance between the most distal point and the most proximal point along the edge of the fossa olecrani, H4: The distance between the most distal point of the fossa olecrani and trochlea humeri, H5: The distance between the proximal edge of the fossa olecrani and the most proximal point of trochlea humeri.

Discussion

The humerus is the longest and largest bone of the upper limb and it is very important to identify the humeral length from the segmental measurements (8). In forensic anthropology, a method for estimating height based on the distances of segments of long bones is important. Steele and Mckern created a method based on the proportionality between determined distances among fixed points of bones and their total length (9). Recent studies show that a person's stature is an extremely variable biological parameter. Morever it has been reported that stature may vary from person to person throughout the day and according to different populations (9–18).

In forensic and archeological studies, the mean value of total humerus length gives important evidence to indicate the characteristic features of a population (4- 6). In this study the mean values of the total humerus length was identified as 304.8 ± 1.8 mm and 307.10 ± 2.1 mm on the left and right side respectively. When we compare our finding with other populations, the results were similar to the Spanish population, but there were significant differences with Bulgarian and Maya populations (7). According to this difference the Bulgarians have greater mean values than Turks whereas the Maya forensic samples have lower mean values (8,18). These findings may point to the existence of possible differences within Caucasian populations. Furthermore, in a study of the Portuguese population made with fresh bones the mean values of total humerus length were greater than our dry bones. It was reported over 100 years ago that dry bones are slightly smaller than fresh ones and this difference has been established as approximately 2 mm. According to this information this difference could be considerable (20).

Proximal humeral fractures are common injuries. They occur along the physeal lines of the proximal humerus and within its segments. Soft tissue attachments including the insertions of the rotator cuff tendons and the deltoid, pectoralis major, latissimus dorsi and teres major muscles can cause displacement of the various parts in proximal humeral fractures and likewise isolated displaced fractures of the greater tuberosity. In anatomic studies it was reported that the highest point on the articular segment of the humeral head is found 6 to 8 mm above from the most proximal point of the greater tuberosity (21,22). This relationship is important because the relative height of the greater tuberosity determines the amount of subacromial clearance as the arm is elevated. Moreover in clinical assessment this point is important for the treatment of isolated greater tuberosity fractures. In our study we found this distance on the left humerus to be 6.6 ± 1.3 mm and on the right humerus 6.5 ± 1.6 mm. Our mean values are similar to other anatomic studies.

In a study from Guatemala with forensic Maya samples, the distance from the proximal point on the articular surface of the caput humeri to the distal point of collum anatomicum was 32.8 ± 2.7 mm. In this study this measurement was 40.9 ± 3.9 mm and 41.0 ± 5.1 mm on the right and left side respectively. It is therefore considered that there are some differences in the mean values of measurement point between our study and Guatemala forensic Maya samples (6,20).

Olecranon fractures occur in 10% of all upper extremity lesions. The lesion might be the result of indirect or direct trauma, especially forced hyperextension of the elbow joint (23). In an archeological study the distance between the proximal and distal margin of olecranon fossa was identified as 20.2 ± 1.9 mm for females and for males as 20.3 ± 1.3 mm whereas the same distance in our study was found to be 24.2 ± 2.07 mm and 23.9 ± 2.63 mm on the right and on the left humerus respectively (24). Moreover in another study the distance between the distal margin of the olecranon fossa and trochlea was identified on the right humerus as 14.2 ± 1.8 mm for males whereas in our study the same measurement was 20.0 ± 2.2 mm and 19.7 ± 2.5 mm on the right and left side, respectively (6).

In the final measurement, the distance from the proximal margin of the olecranon fossa to the distal trochlea was found to be 40.6 ± 3.3 mm on the right side and 39.7 ± 3.4 mm on the left side. The distal humerus has an unique and special anatomy and it freely articulates with the radius and ulna. Complex distal humerus fractures provide reconstructive problems and complications such as damage to the nerve and blood vessels. Therefore these fractures are difficult for orthopedic surgeons to treat. Various implants are available for the diverse fracture patterns observed in the distal humerus and these plates are contoured specifically for the anatomy of this region. Several companies have developed anatomically based precontoured condylar plate systems that can assist with fracture reduction (25).

When comparing similar studies in the literature with this study, there is similarity between the mean value of the distance from the humeral head to the greater tuberosity. On the other hand, the mean value of the total humerus length was similar only to Spanish population whereas there are differences between Mayas, Bulgarians and Porteguese. However, differences are found in the mean values of the distance from the articular surface of the caput humeri to the collum anatomicum and the distance from the distal margin of the olecranon fossa to the trochlea between Maya samples and Bulgarians. Some differences are also found in the mean value of the olecranon fossa height compared with an archeological study and our readings. We consider that these discrepancies could be a result of factors such as age, sex, race and also environmental factors affecting bone growth, such as nutrition, physical development and genetic factors. Moreover these diversities could depend on the differences in the reference points which are taken as criteria in the measurements

We believe that knowledge of the morphometric values of humerus segments are important in forensic, anatomic and archeological cases in order to identify unknown bodies and stature. It is also helpful for the clinician in the treatment of proximal and distal humerus fractures. Therefore our study supplies the mean values of the different morphometric measurements from the humerus. As a result, these measurements may help to indicate the characteristic morphological features of humerus segments in our Turkish population and also help the orthopedic surgeon to place the various implants in the reconstruction of humerus fractures.

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