Original research article

Morphometric analysis and clinical significance of humeral condyles in dry bone

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Abstract

Aim: The aim of this study was to determine the morphometric of humeral condyles in dry bone and its clinical importance.

Materials and methods: A descriptive study was done in the Department of Anatomy, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India for one year. In the present study 80 numbers of dry humerii were collected from the Department of Anatomy. Ten different parameters of humerus were measured to study the morphometry of the humerus by using digital caliper, measuring tape, graph paper, card board and measuring scale.

Results: Among 80 humerus (out of which 45 are of left side and 35 are of right side) to determine the different parameters of the humerus. The maximum length of the humerus was 284.39, ± 23.51 mm on left side and 291.20, ± 19.70 mm on the right side. Maximum transverse diameter was 39.21, ± 5.81 mm on left side and 36.91, ± 6.12 mm on the right side. Maximum vertical diameter of head was 41.96, ± 6.17 mm on left side 43.04, ± 5.42 mm on the right side. The maximum diameter of girth of head was 125.87, ± 12.78 mm on the left side and 137.61, ± 47.67 mm on the right side. The breadth of trochlear on the left side was 26.85, ± 3.79 mm and 27.11, ±3.64 mm on the right side. The maximum diameter of shaft of humerus was 32.76, ±32.6 mm on left side and 32.04, ± 4.45 mm on the right side. The minimum diameter of shaft was 27.20, ± 2.90 on the left side and 26.55, ± 3.36 mm on the right side. Antero-posterior diameter of trochlea was 28.46, ± 2.81 mm on left side and 28.61, ± 2.76 mm on the right side. The distance between the medial and lateral condyle of humerus on the left side was 57.14, ± 6.44 mm and 58.67, ± 6.36 mm on the right side. The surface area of head of the humerus was 23.26, ± 4.80 mm on the left side and 23.20, ± 5.12 mm on the right side.

Conclusion: we concluded that the morphometric measurements of segments of humerus is important for Anatomist, Forensic Science and Archaeologist to identify the relationship between length of long bones and height of living as well as unknown bone fragments which may be influenced by different factors such as ethnicity, age, sex, race and culture. It is also helpful for the clinician to treat the proximal and distal fracture of humerus and also help the orthopaedic surgeon in various reconstructive surgery of humerus for implantation. **Keywords:** Humerus, Anthropometry, Digital Caliper, Morphometry

Introduction

Anthropometry measurements are very useful to estimate stature and bone length from the skeletal remains from anthropological remnant skeletons. The very important step in assessing health and general body size trends away the given populations is stature estimated from the human skeletal remains.[1]and it is also have an important role in the identification of missing persons into medical legal investigations[2], finding the mean values of different humerus segment helps in forensic and anthropometric practice. Mullar was measured five segments by using the margins of articular surfaces and key points of muscle attachment[2] these findings are very useful to determining the humerus segment. Remains of long bones of the individual is very important in anthropological practice for morphometric analysis in case of pelvis and cranium[3]and long bones such as tibia and femur of the lower limb collectively remains the best for the assessment of the living stature of the individual.[4,5]Celbis[6] stated that in case of absence of lower limb bones the estimation of living stature can be done by the help of remains of upper limb bones such as humerus, radius and ulna. In many situations the full length of long bones may not be available but only segments of bones may available in that case some methods can be used, as per as studies of Wright[3]in case of humerus segments and Mysorekar`s[7]two studies in case of radius, ulna, femerus and tibia. Depending on Munoz et al [8]study we can find out the total humerus length by a remains of humerus segment, for estimating of sex from whole skeletal or remains. There are two methods qualitative morphological examination remains the quickest and easiest method and in experienced scientists results in95-100% accuracy.[9] In terms of repeatability, data evolution, objectivity and applicability to both cranial and post cranial the morphometric methods are most considered.[10] Many studies were confirmed the humerus by using classical osteometric techniques, the humerus is one of the strongest long bones of the skeleton which even in a fragmented state is likely to be recorded in a forensic case.[11]The present study is conducted for morphometric analysis of humerus segments.

Materials and methods

A descriptive study was done in the Department of anatomy, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, India for one year.

Methodology

In the present study 80 numbers of dry humerii were collected from the Department of Anatomy. Ten different parameters of humerus were measured to study the morphometry of the humerus by using digital caliper, measuring tape, graph paper, card board and measuring scale.

- Maximum length of humerus: It measures the distance between the highest point of the head of the humerus to the most distal point of the trochlea Maximum transverse diameter of the head: It measures the straight distance between the most lateral points on articular surface of the head.
- Maximum vertical diameter of the head: It measures the straight distance between the highest and lowest points on the articular surfaces, taken at right angle to the transverse diameter.
- Girth of the head: It measures the circumference of the head along its articular surface.
- Breadth of the trochlea: It measures the breadth between the midpoint of the lateral margin of the trochlea and midpoint of lateral margin of capitulum.
- Maximum diameter of the shaft.
- Minimum diameter of the shaft.
- Anterior-posterior diameter of trochlea.
- Distance between medial and lateral epicondyle.
- Surface area of the head of the humerus.

All the parameters were recorded and analysed statistically by using SPSS 16. The mean and standard deviation was calculated.

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Results

The present study was conducted in 80 humerus (out of which 45 are of left side and 35 are of right side) to determine the different parameters of the humerus.The maximum length of the humerus was 284.39, ± 23.51 mm on left side and 291.20, ± 19.70 mm on the right side. Maximum transverse diameter was 39.21, ± 5.81 mm on left side and 36.91, ± 6.12 mm on the right side. Maximum vertical diameter of head was 41.96, ± 6.17 mm on left side 43.04, ± 5.42 mm on the right side. The maximum diameter of girth of head was 125.87, ± 12.78 mm on the left side and 137.61, ± 47.67 mm on the right side. The breadth of trochlear on the left side was 26.85, ± 3.79 mm and 27.11, ±3.64 mm on the right side.

Table 1: Showing the Length, MTDH, MVDH, GoHead and Trochlea Mean, STD of Left and Right Humerus

Side	Length	MTDH	MVDH	GOHead	BOTROCHLEA
Left Mean	284.39	39.21	41.96	125.87	26.85
N	45	45	45	45	45
STD DEV	±23.51	±5.81	±6.17	±12.78	±3.79
Right Mean	291.20	36.91	43.04	137.61	27.11
N	35	35	35	35	35
STD DEV	±19.70	±6.12	±5.42	±47.67	±3.64
Total Mean N STD DEV	287.79 80 ±21.60	39.56 80 ±5.96	42.50 80 ±5.79	131.74 80 ±30.26	26.98 80 ±3.71
F-Value	1.332	0.275	0.649	1.495	0.118
P-Value	0.262	0.657	0.446	0.233	0.742

The maximum diameter of shaft of humerus was 32.76, ±32.6 mm on left side and 32.04, ± 4.45 mm on the right side. The minimum diameter of shaft was 27.20, ± 2.90 on the left side and 26.55, ± 3.36 mm on the right side. Antero-posterior diameter of trochlea was 28.46, ± 2.81 mm on left side and 28.61, ± 2.76 mm on the right side. The distance between the medial and lateral condyle of humerus on the left side was 57.14, ± 6.44 mm and 58.67, ± 6.36 mm on the right side. The surface area of head of the humerus was 23.26, ± 4.80 mm on the left side and 23.20, ± 5.12 mm on the right side (Table 1).

Table 2: Showing the MxDOS, MnDOS, APDOT, DBMAL and SURAH Mean, STD of Left and Right Humerus

SIDE	MxDOS	MnDOS	APDOT	DBMAL	SURAH
Left Mean	32.76	27.20	28.46	57.14	23.26
N	45	45	45	45	45
STD DEV	±32.6	±2.90	±2.81	±6.44	±4.80
Right Mean	30.04	26.55	28.61	58.67	23.20
N	35	35	35	35	35
STD DEV	±4.45	±3.36	±2.76	±6.36	±5.12
Total Mean	32.07	26.87	28.54	57.89	23.23
N	80	80	80	80	80
STD DEV	±4.29	±3.14	±2.87	±6.39	±4.91
F-Value	0.577	1.142	0.078	0.988	0.003
P-Value	0.452	0.287	0.765	0.318	0.963

(MxDOS- Maximum Diameter of Shaft, MnDOS- Minimum Diameter of Shaft, APDOT- Anterior Posterior Diameter of

Trochlea, DBMAL- Distance Between Medial and Lateral Epicondyle, SURAH- Surface Area of Head of Humerus)

Table 3: Comparative Studies carried out by different Authors on Humerus

Authors	Year	Length	MVDH	MTDH	GoHead	BoTrochlea	APDOT	MxDoS
S.D A K Man	2005	L 304.8, ± 1.8 R 307.10, ± 2.1	40.9, ±3.9 41.0, ±5.1	-	-	40.6, ±3.3 39.7, ±3.4	-	-
S.D Desai et al	2012	L 289.4, ±21.8 R 292.3, ± 22.9	-	-	-	-	-	-
Niraj P et al	2013	L 307.27, ±16.13 R 308.58, ±19.17	-	-	-	-	-	-
Lokanadham et al	2013	M 310.97, ±0.15 F 280.65, ±0.15	30.27, ±0.03 20.96, ±0.04	40.37, ±0.42 30.49, ±0.04	120.96, ±0.09 110.52, ±0.12	20.34, ±0.022 20.09, ±0.034	-	40.39, ±0.42 30.492, ±0.04
Ashiyani et al	2016	L 300.32, ±1.58 R 300.39, ±1.66	-	-	-	-	10.45, ±0.15 10.15, ±0.14	-
Pranoti et al	2017	L 283.36, ±22.48 R 290.17, ±18.67	40.93, ±5.14 42.01, ±4.39	38.18, ±4.79 38.85, ±5.09	124.84, ±11.75 136.58, ±46.64	25.82, ±1.97 26.08, ±2.61	27.43, ±1.97 27.58, ±1.73	31.73, ±31.3 31.01, ±3.42

Discussion

One of the longest bone in the human boby is humerus belongs to upper limb, in forensic and anthropological practice it plays very important role because of it important to identify the its length from the segmental measurements.[12] this method is an essential step in assessing health, sexual dimorphism and the general body size that trends among the past populations. According to study of France[13] morphometry of distal segments of humerus is very important because of its sexual dimorphism and humerus is subjected to greater functional stress. Researchers agree that epiphyseal structure tend to be more dimorphic than long.[14,15]

It's very important to identify the humeral length by segmental measurements which are applicable for anatomist, anthropologist and forensic specialist in various studies. It is also essential for the surgeons in fractures of upper and distal end of the humerus. Thus knowing these segment measurements, which are defined is very helpful for determining the humerus length.[16]

In this study, The maximum length of the humerus was 284.39, ± 23.51 mm on left side and 291.20, ± 19.70 mm on the right side. In comparison to the findings of this study, the total mean values of the total humerus length was 284.39, ± 23.51 mm and 291.20, ± 19.70 mm on the left and right respectively. The results were similar with the studies done by S D Desai et al.[17,18]

Maximum vertical diameter of head was 41.96, ± 6.17 mm on left side 43.04, ± 5.42 mm on the right side, which were similar with the measurements of S D Akmann et al.[19] (Table 3).

In a study done by Lokanadham et al, the maximum transverse diameter of head of humerus was 40.37, ± 0.420 mm in males and 30.492, ± 0.042 mm in females, whereas in this study the measurement was 39.21, ± 5.81 mm and 36.91, ± 6.12 on the left and right side respectively. In our study the maximum diameter of girth of head was 125.87, ± 12.78 mm on the left side and 137.61, ± 47.67 mm on the right side which are similar with the study done by Lokandham et al.[20]

The breadth of trochlear on the left side was 26.85, ± 3.79 mm and 27.11, ±3.64 mm on the right side whereas study done by Lokandham et al were 20.34, ± 0.022 mm in males and 20.09, ± 0.034 mm in females.[20]

Antero-posterior diameter of trochlea was 28.46, ± 2.81 mm on left side and 28.61, ± 2.76 mm on the right side which was different from the study done by Ashiyani et al which were 10.45, ± 0.15 mm on the right side and 10.45, ± 0.17 mm on the left side.[21] The maximum diameter of shaft of humerus was 32.76, ±32.6 mm on left side and 32.04, ± 4.45 mm on the right side, whereas study done by Lokanadham et al the measurements were 40.378, ± 0.420 mm in males and 30.492, ± 0.042 mm in females.[20] The final measurement done in this study was surface area of the head of humerus. The surface area of head of the humerus was 23.26, ± 4.80 mm on the left side and 23.20, ± 5.12 mm on the right side. No previous data were found in relation with the surface area of the head.

Conclusion

we concluded that the morphometric measurements of segments of humerus is important for Anatomist, Forensic Science and Archaeologist to identify the relationship between length of long bones and height of living as well as unknown bone fragments which may be influenced by different factors such as ethnicity, age, sex, race and culture. It is also helpful for the clinician to treat the proximal and distal fracture of humerus and also help the orthopaedic surgeon in various reconstructive surgery of humerus for implantation.

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