

# A Morphometric Study to Find Correlations among Various Dimensions of Proximal End of Humerus of Telugu Population

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## Abstract

**Background:** Long bones from skeletal remains are useful for identification of the deceased, estimation of stature, determination of sex etc. in case of fracture of proximal humerus, the contra lateral head dimensions are used as a template for making prosthesis in replacement surgery.

**Aims and Objectives:** To study and compare the morphometric data of proximal end of humerus of Telugu population with similar studies of other ethnic populations, and generate regression equations using the measured parameters.

**Material and Methods:** Study was conducted on 159 unpaired dry humeri (72 right and 87 left) from the collection of Department of Anatomy, Mamata Medical College, Khammam, Using slide calliper and Osteometric board.

**Results:** The mean of maximum length of humeri of right/ left side were  $309.88 \pm 20.07/ 303.97 \pm 22.07$ , the mean of transverse diameter of humeri of head of right/ left were  $38.95 \pm 3.38/38.21 \pm 3.68$ , the mean of vertical diameter of humeri of right/ left were  $42.77 \pm 3.86/41.28 \pm 3.84$ , the mean of circumference of surgical neck of right/left were  $81.18 \pm 8.47/79.58 \pm 7.30$ . Circumference of surgical neck had a strong positive correlation with transverse diameter & vertical diameter of head which was statistically significant ( $p < 0.001$ ).

**Conclusion:** The morphometric parameters of proximal end of right humeri were found to greater than that of the left humeri. The mean humeral length was similar to that found in studies of various Indian populations.

**Keywords:** *Morphometry, Correlation, Humerus, Proximal.*

## Introduction

Skeletal remains are an important tool for the identification of the deceased for estimation of stature, determination of sex and general body structure of an

ethnic population<sup>[1]</sup>. The skull bone and Pelvis remains are the best and most important bones for medical, legal and forensic investigation but in absence of pelvis and cranium, other long bones are also noted to be of great help in estimation of stature, sex determination and identification of a person .

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Some studies have reported that lower limb bones, especially the length of femur is most closely correlated to stature , but according to Celbis et al<sup>[2]</sup> in absence of lower limb bones, the upper limb bones are also useful for estimation of stature. As per some studies the

total length of the long bone and the stature can also be estimated even from fragments/ segments of long bone.

In case of fracture of proximal Humerus, the contra lateral Humerus head size is used as a template for making prosthesis in replacement surgery. But some studies have shown the presence of high inter-specimen and side-specific variability. Hence the restoration of normal anatomy during replacement surgery becomes difficult, so it is important to match the normal anatomy as much as possible to attain better function of shoulder joint<sup>[3]</sup>.

In a cadaveric model of Harryman et al<sup>[4]</sup> use of large size humeral head component showed diminished shoulder joint movements. Likewise when a smaller head component was used, the range of movement reduced due to reduction of surface arc available at glenohumeral joint<sup>[5]</sup>.

Thus one of the important factors for arthroscopic repair failure is disproportion of head of Humerus with respect to the corresponding glenoid cavity<sup>[6]</sup>, it has been observed that if the surface area of contact between head of Humerus & glenoid fossa reduces, the instability of the shoulder joint increases<sup>[7]</sup>. In Indian population only the lower size prosthesis fits in replacement surgery of shoulder joint, else restricted movements and discomfort of joint were reported<sup>[8]</sup>. Osteochondral allograft transplantation technique is popular nowadays to create a congruent, mechanically stable joint without much alteration in surrounding anatomy<sup>[9]</sup>.

Study of Kornberg<sup>[10]</sup> shows a significant difference in retroversion of humeral head between dominant and

non-dominant side, i.e more used and less used sides. Edelson<sup>[11]</sup> also found that in both male and female right Humeri were significantly more retroverted than left humeri.

The aim of present study is to obtain and analyze the morphometric values of proximal end of humeri, to compare with the findings of other similar studies, as well as to provide data and correlations to predict the morphometric dimensions useful for prosthetic preparation.

## Materials and Methods

### Materials:

The study was conducted on 159 dry unpaired intact humeri ( 72 right and 87 left ) of unknown age and sex, from the collection of the Department of Anatomy, Mamata Medical College, Khammam, Telangana. Damaged bones or bone attached with prosthesis was discarded from the study. Osteometric board and Vernier calliper were used to take the measurements.

### Methods:

The maximum length of humeri was measured using a Osteometric board. The vertical diameter and transverse diameter of head of humeri and the circumference of surgical neck was measured using a Vernier calliper **Ref Fig1**. The Pearson correlation coefficients(*r*) between the various morphometric dimensions and significance of the correlations coeff were calculated. The regression analysis of the observed data was done using the Data Analysis tool pack of MS Excel for windows and the trend line plots were generated.



**Fig: 1 Measurement of Transverse dia, vertical dia and Humeral length**

**Result**

The mean, standard deviation, minimum & maximum length and range were calculated for all the morphometric dimensions of humeri, the same parameters were also calculated for the left and right humeri separately **Ref Table-I**. Paired test was not carried out to assess the difference between the right and left humeri, as the available bones had not been tagged for Right and Left humeri from the same individual.

**Table I: Data from statistical analysis of the humeral dimensions for combined and segregated data for left and right (mm)**

Parameters	Mean + SD (mm)			Minimum(mm)		Maximum(mm)	
	Combined	Right Humerus	Left Humerus	right	Left	Right	Left
Max Length	304.695 + 30.379	309.875 + 20.753	303.977+22.066	265	255	381	376
Tr D head	38.542+ 3.559	38.946+ 3.383	38.208+ 3.684	31	25	47	45
Vertical D head	41.955+ 3.912	42.765+ 3.860	41.284+ 3.848	33	32	51	51
Circum surgical neck	80.302+ 7.87	81.181+8.471	79.575+ 7.305	63	64	100	100

The Regression equations and the Correlation among various Humeral dimensions were calculated using MS excel data analysis pak. For the regression equations and corresponding Scatter plots are tabulated in **Table:III**, and the regression trend line is shown in **Fig-2 &3**.

A very strong positive correlation exists between Transverse dia to Vertical dia for both right and left humeral heads ( 0.893 / 0.905). The circum surgical neck Dia also has a strong correlation with Transverse dia & Vertical dia **ref Table:II**. The humeral length was also noted to be having a strong correlation with the proximal morphometric dimensions a shown in **Table:II**.

**Table II The Regression equations and the Correlation among various Humeral dimensions**

Y to x	Regression equations		Correlation coeff	
	Right Humerus	Left Humerus	Right Humerus	Left Humerus
Transverse dia to Vertical Dia	$y = 0.783x + 5.4607$	$y = 0.8669x + 2.4204$	0.893	0.905
Transverse dia to Circum Surgical dia	$y = 0.9457x + 5.1493$	$y = 1.2693x + 31.078$	0.736	0.64
Vertical dia to CircumSurgical dia	$y = 1.4972x + 17.151$	$y = 1.2812x + 26.683$	0.682	0.675
Transverse dia to Max Length	$y = 0.0973x + 8.787$	$y = 0.1085x + 5.2253$	0.597	0.65
Vertical dia to Max length	$y = 0.1291x + 2.7672$	$y = 0.1181x + 5.3892$	0.694	0.677
Max length vs Circum surgical len	$y = 1.3531x + 200.03$	$y = 1.5922x + 177.28$	0.552	0.527

**DISCUSSION:**

Humerus is the longest and strongest bone of upper extremity and it can withstand chemical and environmental assault for a longer duration, the durability of Humerus has made it the commonest bone for forensic and anthropometric study. Je-Hun-Lee et al, created a specific formula of regression equation to predict the stature of Korean individuals in their study of segments of long bones<sup>[12]</sup>.

Study of the segments of long bones is also helpful

for providing data and correlation factors which has enormous importance while making prosthesis for replacement surgery of a bony part in Osteochondral allograft transplantation.

Present study has found that measurements of humeral length for right side has higher values than left side, which is in accordance with many other studies as shown in **Table:III**. Mean value of humeral length (right and left combined data) in our study is also comparable with the results of the various ethnic populations enumerated in **Table:III**.

**Table III Comparative results of right & left Humeral length of various ethnic populations**

Studies	Mean Length of right Humeri	Mean Length of left Humeri
S D Desai [13]	292.3 mm ± 22.9mm	289.45mm ± 21.8mm
Vettivel et al [14]	302.0mm ± 20.0mm	301.0mm ± 20.0mm
Udhaya et al [15]	302.8 mm ± 24.4mm	289.45mm ± 21.8mm
Zarana et al. [16]	303.9mm ± 16.6mm	303.2mm ± 15.8mm
Aydin et al [17]	304.1mm ± 17.3mm	300.4mm ± 23.9mm
Anil Kumar [18]	306.4mm ± 25.8mm	304.44mm ± 23.8mm
Akman [19]	307.1 mm ± 20.8mm	304 mm ± 18.9mm
Niraj et al [20]	308.5mm ± 19.16mm	307.2mm ± 16.13mm
Somesh et al [1]	309.6 mm ± 20.6mm	299.6 mm ± 22.5mm
B V Murlimanju [21]	309.8mm ± 18.1mm	299.6mm ± 25.4mm
Salles et al [22]	313mm ± 17.71mm	300.85mm ± 18.35mm
Present study	309.87mm ± 20.7mm	303.98mm ± 22.07mm
	<b>Humeral length Combined</b>	
Anudeep Singh etal	305.42 mm ± 1.4mm	North Indians
Akman et al	305.95mm ± 1.6mm	Turkish
Papaloucas [23]	330.67mm ± 3.5mm	Athenian
Derya Atamturk et al [24]	324.16mm ± 32.21mm	Istanbul
Mall Gita et al [25]	320.50mm ± 19.09mm	Munich and Colonge
Sinchal Datta	304.69mm± 30.38mm	Present study

The mean of vertical diameter and transverse diameter of head of humeri were found to be  $41.95 \pm 3.9$ mm and  $38.54 \pm 3.5$ mm respectively, which is comparable with corresponding findings of Ajari Ashutosha et al e.g  $43.11 \pm 3.73$ mm and  $39.65 \pm 2.97$ mm respectively. The vertical diameter of right and left side humeral head were found to be  $42.77 \pm 3.86$ mm and  $41.28 \pm 3.85$ mm and the transverse diameter on right and left humeral head were found to be  $38.95 \pm 3.38$ mm and  $38.21 \pm 3.68$ mm respectively, both the right side dimensions are greater than left side dimensions as in many other studies, whereas in the study of Aydin Kabakci et al the left side shows little higher value than right side. In the study of Jacek Tomczyk et al [26] the vertical and transverse diameters of male were found higher than female which they have used for determination of sex.

The mean of circumference of surgical length was  $80.3 \pm 7.8$ mm and the same on right and left side were  $81.18 \pm 8.47$ mm and  $79.57 \pm 7.31$ mm respectively, which is different from the findings of Aydin Kabakci et al where the same for right and left humeri were found to be  $86.9 \pm 9.9$  and  $93.2 \pm 8.5$  respectively, with a higher value on left side.

So, in our study all the parameters of humeri were found to be more on right sided than left side, which is in accordance with many other studies on different population. Many previous studies have shown a right-bias in the dimensions of upper limb bones along with contra lateral asymmetry in lower limb bones, termed as crossed symmetry [27].

The transverse diameters of head of humeri were found to be having a strong positive correlation with the vertical diameters of head of humeri. The 'r' value (Pearson correlation coefficient) was 0.898 was highly significant ( $p < 0.001$ ). The same correlation for right/left side were found to be having r values (Pearson correlation coefficient) 0.893/0.905, and the correlations were found to be highly significant,  $p < 0.001$  for both sides.

The transverse diameter of head of humeri was found to have a very good positive correlation with the circumference of surgical neck. The r value was 0.684 and  $p < 0.001$ . The same correlation for right / left side were found to be with r value 0.736 / 0.640 respectively, which is also very good correlation with p value  $< 0.001$ .

Very good positive correlation was also found between vertical diameters of head of humeri. and circumference of surgical neck of humeri, with r value of 0.680 and  $p < 0.001$ . The same correlation on right/left sides were found to be 0.682/ 0.675 respectively with  $p < 0.001$  for both side Humeri.

In case of bone replacement surgery minor differences may cause functional difficulty and movement restriction after surgery, if the exact size of the contra lateral uninjured side is been taken for size determination of the prosthesis. Hence variations in the humeral head dimensions for right and left side must be considered for prosthesis development. So if circumsurgical neck dia is available then the transverse and vertical dia can be calculated for the development of the prosthesis, though data of the corresponding ethnic populations is required for patients belonging to a ethnic group.

## Conclusion

The morphometric dimensions of proximal end of humerus measured in the present study were found to be higher for the right humeri compared to the left humeri, which is similar with many similar studies.

The length of humeri has shown significant variations among different populations. The Athenian, Istanbul, Munich & Cologne population have more humeral length than Indian population. The present study shows similarity in the humeral length found in different studies on Indian population.

Variations in transverse and vertical diameter was noted for right and left sides in the present study.

There is a strong highly significant ( $p < 0.001$ ) positive correlation between the circumsurgical neck and the transverse and vertical dia of the humeral head. A strong highly significant ( $p < 0.001$ ) correlation was observed between the circumsurgical dia, transverse dia and vertical dia with the humeral length. The regression equations generated will help to predict the proximal humeral dimensions in an event of unavailability of a particular morphometric dimension and also in determination of the inter specific and side specific variability of the humeral head of Indian Telugu population, thus providing data and helping in

better determination of size of the prosthesis in bone replacement surgery for telugu population. The study can be expanded over other ethnic populations of India to prepare a comprehensive database and correlations for various communities.

**Conflict of Interest:** None

**Source of Funding:** None

**Ethical Clearance:** Permission for the study was taken from the Institutional Ethics Committee of Mamata medical College. The bones used in the study are from the collection of the Department of Anatomy, Mamata Medical College, Khammam, Telengana.

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