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Morphometric Study of Humerus in Southern Indian Population

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Abstract

Anthropometry involves measurement of proportions of the human body such as muscles, adipose tissue and bone. The present study was aimed at determining the humeral lengths segments and comparing it with its entire length of humerus in southern part of Indian population. This can be helpful in approximating stature of individuals using typical regression equation. We also compared the data obtained with previous studies conducted on various people in the world, which are valuable both forensic and archaeological studies. One hundred and nineteen fully ossified dried and processed humerus bones (60 right, 59 left humerus) obtained from two medical colleges in Tamil Nadu state SRM medical college, hospital and research centre and Sri Ramachandra Medical College. The morphometric detail of the parts of humerus were measured using digital Vanier caliper. The 6 segments' length precisely, from utmost proximal point of the head of humerus to the utmost distal point of the circumference of the head as section 1 (Sa-Sb), from the distal point of the circumference of the head to the convergence of two areas of muscle attachment as section 2 (Sb-Sc), and from the convergence of two areas of muscle attachment to the deltoid tuberosity as section 3(Hc-Hd), from deltoid tuberosity to upper margin of olecranon fossa as section 4(Sd-Se), From upper margin of olecranon fossa to the lower margin of the fossa as section 5 (Se-Sf), and from the lower margin of olecranon fossa to most distal point of trochlea as section 6 (Sf-Sg) and maximum length of humerus were measured to the nearest millimeter. The values obtained for the distance of each sections were 35.22±3.939mm, 44.53±5.025mm, 66.27±6.805mm, 125.54±11.429mm, 20.51±1.726mm, and

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18.51±1.633mm respectively on the left side, making a total of 310.5763±23.257mm. The values obtained on the right distance segments are as fellow 34.48±3.223mm, 47.05±6.31mm, 67.10±6.942mm, 125.54±11.429mm, 20.51±1.726mm and 17.90±2.447mm respectively on the right side, making a total 311.767±23.435mm. In conclusion present study shows that there is no significant difference obtained for the morphometric measurements between left and right segments except in segment 2.

Keywords: Anthropometry, Humerus, Measurement, Ossified, Segment.

INTRODUCTION

Anthropometric dimensions are very important tools in the estimation of height and length of bone from the skeletal remains. Also having a significant role in the proof of identity of lost people into medical authorized investigations (Wright & Vasquez, 2003), the average values of different segment of the humerus that support in anthropometric and forensic practice. Individual's height play a vigorous role for medico-legal investigations. Hence, in the field of forensic anthropology, stature projection from bones shows a significant role in the proof of identity of missing persons (Ross & Konigsberg, 2002). Anthropometry involves measurement of dimensions of the human body such as muscles, adipose tissues and bones. Deployment of anthropometric techniques by anthropologists to estimate body size and subsequently used by medical scientist have been practised for over hundred years. Attention in stature reconstructing from skeletal remnants has been long to the early 1800s. Limb bones of body (human) which have been used for the stature estimation were reconstructed, by means of the regression formulae for a long bone (Nath & Badkur, 2002).

One of the major aspects considered in instituting the uniqueness of a person is stature, and often skeletal remains are found in fragments. Therefore, a suitable technique needed for mounting estimate of stature through fragments of the skeleton. To estimate their total length using their scrappy bone length, and to employ them in stature formulae, thus to estimate the total length of individual (Walton, 1980). In a country like India, exposed and unidentified dead bodies are frequently damaged by wild animals gnawing the skeletal remains. Fragments of Bone, frequently with end destroyed, are brought to forensic case works. In both archaeological and forensic practice, fragments of long bones are often presented as the only available sources to establish identity. For these reasons estimation of stature becomes the most important job work in such a situation. If there is no bones of skeleton, long bone with intact ends can be used by applying the derived method to the available fragment of bone (Dan utpal *et al*., 2009).

The presentation of osteometry is of utmost importance in forensic medicine, medico-legal investigation for achieving the goals of estimating the age at the time of death, race, sex, ancestry, body weight, body built, ethnicity/ stature, detail of individualizing characteristics i.e. Fractures, Amputation, ankylosis deformities and bone pathologies and to some level the course of death if revealed in the skeletal remains (Shande *et. al* 2009).The present study was aimed at determining the humerus total length through the measurements of its different segments in southern Indian residents which can ultimately be used in assessing the stature of individuals using regression formulae. This present research is significant for use in forensic and archaeological evaluation which will help in the implementation of laws in order to accomplish vital aim for individual proof of identity.

MATERIALS AND METHODS

Study area

The present study was conducted one of the major ethnicities in the Tamil ethnicity in Chennai, Tamil states, India, which is most populated state in southern Indian. Chennai is a major administrative and cultural centre, with a population of over 7.1 million people. The city has irregular shape covers 426 sq km^2. Climate is warm and humid. It reaches average temperature of 89 ^{0}F (32 ^{0} C) in May and 77 ^{0}F (25 ^{0} C) in January (Alain and Kenneth, 2003).

Study plan

The present study accepted a cross sectional

Collection of samples

One hundred and nineteen (119) fully ossified dried and processed humerus bones (60 right, 59 left) were obtained from two medical colleges in Tamil Nadu state, 1. SRM medical college, hospital and research centre 2. Sri Ramachandra Medical College). No sex determination was done as well as no identification of bones from the same body. Damage bones were not used for the present research. Similarly, unossified, fractured bones or bones with any pathology were excluded.

Method of data collection

Based on the morphological features of humerus, the landmarks for the measurements of the humerus were subdivided into six (6) sections. From the proximal termination (top part of the head) to the distal termination (trochlear), as shown in Figure 1.

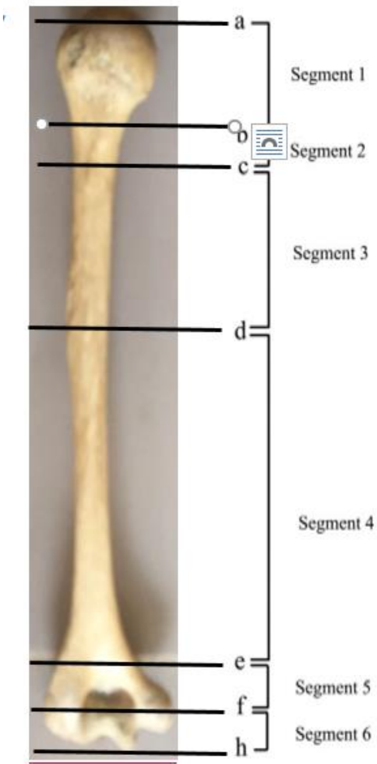

Figure 1: Picture of left humerus bone indicating the segments.

The lengths of each segment was measured using Vernier calliper to the nearest millimetre (mm).

Figure 2: Some of the humerus used in the present study

Statistical analyses

Measured results for each segment were expressed as mean ±SD and used for comparison. Sections number one to six on the left side were compared with matching sections on the right by means of independent t – test. Analyses of variance (ONE WAY) was used to find out the difference between groups. $P < 0.05$ was considered as level of significance difference.

Results

From table 1 on the left side humerus a total of fifty-nine (59) left humerus were analysed, which are divided into six (6) sections ANOVA test revealed there were significant differences between the segments ($F= 2255.717$, $df = 5$, $p < 0.05$) and from the post host assessment there were significant differences among the pair of all segments with the exception of segments 5 and 6 which showed insignificant differences ($p < 0.05$). Segments 4 and 6 showed higher means differences as compared to other pair of segments while segments 1 and 2 showed the least significant differences among the significant pairs.

From table 2 on the right-side humerus, a total of 60 right humerus were statistically analysed and overall significant difference ($F = 2590.932$, $df = 5$, $p < 0.05$), in the post host comparison in which segment 5 and 6 are statistically insignificant. And all other pairs of segments were found to be significant. Segment 4 and 6 have greater mean differences among significant pairs and segments 1 and 2 have lowest significant mean difference similar to the humerus on the left-side.

On table 3 shows significant changes in mean proportion in left humerus (left $f = 2555.217$, $df =5$, $p < 0.05$), the ANOVA showed significant proportion in all the pairs of segments except for the segment 5 and 6 left ($p = 0.480$).

On table 4 there are significant differences in mean proportion in right humerus (right, $f = 2590.\ 932$, $df =5$, $p< 0.05$), in the right side of the humerus, the ANOVA shows significant proportion in all the pairs of segments except for the segment 5 and 6 right.

On table 5 showed the comparison, using independent t-test, of the average lengths in left sections of humerus when compared to the right side. There was a statistically significant differences with p value of 0.017.

Table 6: Shows the comparison of the average proportion of matching right and left sections of the humerus. Level of statistical significance was 0.026.

Table 1: The average length of six sections of left humerus

Side	Sections	N	Mean±SD	95% confidence Interval mean		'f' value	'p' value
				Lower boundary	Upper boundary		
Left	Sections 1	59	35.22±3.939	34.19	36.25	2555.72	P< 0.05
	Sections 2	59	44.53±5.025	43.22	45.84		
	Sections 3	59	66.27±6.805	64.5	68.04		
	Sections 4	59	125.54±11.429	122.58	128.52		
	Sections 5	59	20.51±1.726	20.06	20.96		
	Sections 6	59	18.51±1.633	18.93	18.93		
	Total Length	59	310.5763±23.257	255.1	364		

N= Sample size

Table 2: The average length of six sections of right humerus

Side	Sections	N	Mean±SD	95% confidence Interval mean		'f' value	'p' value
				Lower boundary	**Upper boundary**		
	Sections 1	60	34.48±3.223	33.65	35.32		
Right	Sections 2	60	47.05±6.312	45.42	48.68	2590.93	P< 0.05
	Sections 3	60	67.10±6.942	65.31	68.89		
	Sections 4	60	125.20±10.742	122.43	127.97		
	Sections 5	60	20.03±2.314	19.44	20.63		
	Sections 6	60	17.90±2.447	17.27	18.53		
	Total Length	60	311.7667±23.435	248	364		

Table 3: The percentage between the average length of left humerus and humeral sections .

	Sections	N	Mean±SD	95% confidence Interval mean		'f' value	'p' value
				Lower boundary	Upper boundary		
Left	Sections 1	59	11.340±1.268	11.01	11.67	2555.72	P< 0.05
	Sections 2	59	14.336±1.618	13.91	14.76		
	Sections 3	59	21.338±2.191	20.77	21.97		
	Sections 4	59	40.422±3.680	39.46	41.38		
	Sections 5	59	6.603±0.556	6.46	6.75		
	Sections 6	59	5.959±0.526	5.82	6.09		

Table 4: The percentage between the average length of right humerus and humeral sections
.

Side		N	Mean±SD	95% confidence Interval mean		'f' value	'p' value
				Lower Boundary	Upper Boundary		
Right	Sections 1	60	11.061±1.034	10.79	11.328	2590.93	P< 0.05
	Sections 2	60	15.0914±2.025	14.56	15.614		
	Sections 3	60	21.523±2.226	20.95	22.097		
	Sections 4	60	40.158±3.445	39.268	41.048		
	Sections 5	60	6.426±0.742	6.234	6.617		
	Sections 6	60	5.742±0.785	5.538	5.944		

Table 5: Comparison between the average lengths of matching right sections and left sections of the humerus

Sections	Side	N	Mean±SD	95% confidence Interval mean		't' value	'p' value
				Lower boundry	**Upper boundry**		
Sections 1	Left Section	95	35.22±3.939	-0.569	2.043	1.118	0.266
	Right Section	60	34.48±3.223	-0.572	2.046		
Sections 2	Left Section	59	44.53±5.03	-4.598	-0.509	-2.411	0.017
	Right Section	60	47.05±6.31	-4.595	-0.454		
Sections 3	Left Section	59	66.271±6.805	-3.324	1.667	-0.658	0.512
	Right Section	60	67.100±6.942	-3.324	1.667		
Sections 4	Left Section	59	125.542±11.42	-3.683	4.368	1.68	0.867
	Right Section	60	125.20±10.742	-3.682	4.371		
Sections 5	Left Section	59	20.509±1.726	-0.267	1.217	1.27	0.207
	Right Section	60	20.033±2.314	-0.266	1.216		
Sections 6	Left Section	59	18.508±1.633	-0.148	1.365	1.592	0.111
	Right Section	60	17.900±2.447	-0.146	1.363		
Total Length	Left Section	59	310.576±23.25	-9.668	7.287	0.278	0.781
	Right Section	60	311.767±23.43	-9.667	7.287		

Table 6: Comparison between the average percentage of matching right and left sections of thehumerus,.

Segments	Side	N	Mean±SD	95% confidence Interval mean		't' value	'p' value
				Lower boudry	Upper boudry		
Sections 1	Left Section	59	11.340±1.2684	-0.14	0.699	1.32	0.19
	Right Section	60	11.061±1.0338	-0.141	0.7004		
Sections 2	Left Section	59	14.336±1.61806	-1.421	-0.089	-2.24	0.026
	Right Section	60	15.091±2.025	-1.42	-0.089		
Sections 3	Left Section	59	21.338±2.191	-0.987	0.617	0.45	0.617
	Right Section	60	21.522±2.227	-0.986	0.617		
Sections 4	Left Section	59	40.422±3.680	-1.029	1.558	0.4	0.687
	Right Section	60	40.158±3.445	-1.031	1.559		
Sections 5	Left Section	59	6.603±0.556	-0.607	0.415	1.476	0.143
	Right Section	60	6.426±0.742	-0.0607	0.415		
Sections 6	Left Section	59	5.959±0.526	-0.025	0.46	1.776	0.078
	Right Section	60	5.741±0.785	-0.0246	0.46		

DISCUSSION

The current study used the humerus for the reason that it is the biggest and elongated bone of the upper limb and it is significant to recognise the length of humerus from the segmental measurement (Williams *et al*., 1989).

The mean total humerus length were 310.58±23.56 and 311.77±23.44mm on the right and left sides respectively. While compared present finding with previous research conducted by Lakshmi *et al*., (2014), total length of humerus in southern Indian population were 306.19±18.02mm and 303.91±19.28mm on the right and left sides respectively. However, Deniz *et al*., (2006) conducted the same research on Caucasian humerus of Turkish population were found to be 307.1±20.8mm and 304.8±18.9mm on the right and left sides respectively and a result from Shilpa *et al*., (2010) were found to be 309.6±20.6mm and 299.6±22mm on the right and left sides respectively. From the above finding shows mean total length of previous studies and present research matched only with research conducted by Shilpa *et al*., (2010) only in the right side but not on the left side.

The landmarks of the present study were the same with the one reported by Lakshmi *et al*., (2014). But in the research by Shilpa *et al*., (2010) and Deniz *et al*., (2006) the landmarks were divided into 5 segments.

The research done by Deniz *et al*., (2006) in a morphometric measurement of humerus segment, the distance from the proximal point on the articular surface of the caput humerus to the most distal point of circumference of the head was 40.9±3.0mm on the right side and 41.0±5.1mm left side, in the Caucasian humerus samples. The distance from the proximal point of the head of humerus to the surgical neck of humerus was 37.1±4.8mm right side and 37.7±4.4mm on the left side, in the study conducted by Shilpa *et al*., (2010). In the research conducted by Lakshmi *et al*., (2014) the distance from proximal point of the head of humerus to the most distal point of the circumference of the head of humerus was 35.55±3.27mm on the right side and 36.08±3.49mm on the left side while in our current study the segment 1 were 34.48±3.32mm on the right side and 35.22±3.93mm on the left sides. Hence, this shows that there is significant differences in the average values between present study and the previous studies because of differences in land marks but our research value in segment1 is similar to that of Lakshmi *et al*., (2014) because of the same land mark. Similarly in the current work the percentage of section 1 to the total of humerus length was found as 11.34±1.268% and 11.06±1.034% on the right and left side and is similar to the research done by Lakshmi *et al.,* for the same section i.e (section 1) which was calculated as 11.87±0.86% and 11.06±0.81% on the right and left side correspondingly.

Humerus proximal part fractures, especially along the epiphyseal line, are common injuries. The uppermost point on the articular section of humeral head is found 6-8mm from the most proximal point of the greater tuberosity (Rommens *et al*., 2004). The relative height of the bigger tuberosity concludes the amount of subacromial clearance when the arm is raised.

Lakshmi *et al*., (2014) in their study obtained 56.17±6.28mm and 54.32±6.03mm on the right and left sides correspondingly for segment 2 while in the current study the values of the same segment were 44.53±5.03mm and 47.05±6.31mm on the left and right sides respectively. So that our values are lower than previous study. The proportion of segment 2 when compared with complete length of humerus was 14.34±1.62% and 15.09±2.03% on the left and right side respectively. This was lower than the study conducted by Lakshmi *et al*., which was 18.34±1.64% and 17.86±1.46% on the right and left side correspondingly. In the study conducted by Muller this value was 7.60% which was very low when compared to our values. The main reason for difference is because variance in growth pattern, race as well as nutrition (Muller, 1935).

In the current research section three (3) had taken to be the position between the convergences the two muscles areas attachment to the deltoid tuberosity. This anatomical land-mark is the same with research conducted by Lakshmi *et al.,* The result of the mean lengths were and 67.10±6.94mm and 66.27±6.80mm on the right and left side correspondingly equated with previous study conducted by Lakshmi *et al*., (2014) which are 65.31±5.52mm and 61.24±7.03mm on the left and right respectively. Our values in segment 3 are slightly higher than that of Lakshmi *et al.,* (2014) in section 4. This section was the most dependable and largest segment when matched with the rest. The average length was and 125.20±10.74mm and 125.54±11.42mm on the right and left sides correspondingly. The results in research conducted by Lakshmi *et al*., 2014 were 113.33±9.50mm and 119.05±10.30mm on the left and right side respectively. Our study values were higher than previous research by Lakshmi *et al.,* 2014. The proportion of the total length was 40.16±3.45% and 40.42±3.68% on the right and left side the present finding was higher compared to Lakshmi *et al*., 2014 whose study showed 38.86± 2.11% and 37.28±1.98% on the right and left side correspondingly. This has additional chance to obtain formula using this section in a living individual.

Olecranon fractures happen in 10% of all higher extreme injuries. The injury influence by direct or indirect trauma, specifically elbow forced hyper extension. The research conducted by Shilpa *et al.,* the result was 19.0 ±2.9mm and 20.1± 3.4mm on the right and left side humerus correspondingly (Shilpa *et al*., 2010). In another research done by Deniz *et al*., 2004 the distance between the proximal distal margins of olecranon fossa were recognized as 23.9±2.63mm and 20.2±207mm on the left and right side correspondingly (Deniz *et al.,* 2004). This corresponded to segment 5 in the current research. The study conducted by Lakshmi *et al*., (2014) in the same segment measured around 19.75±2.76mm and 21.56±2.08mm on the right and left side. In the present research this segment measured around 20.51±1.72mm and 20.03±2.31mm on the left and right side correspondingly. The distance between distal margins of olecranon fossa to the distal margin of trochlea in our study which is segment 6. It measured 17.90±2.44mm and 18.51±1.63mm on the right and left side humerus section correspondingly. Present result is similar to the research conducted by Shilpa k *et al.,* which was measured 17.3±3.3mm and 16.8±2.2mm on the right and left side humerus section separately. As compared to the research done by Deniz *et al*., the same segment the values in present study was higher than in their study, S Deniz *et al*., obtained 20.0±2.2mm and 19.7±2.5mm on the right and left side correspondingly. Result by Lakshmi *et al.,* on the same segment was lower than our finding which measured about 13.31±2.35mm and 14.43±2.17mm on the left and right side separately. Because of articulation with radius and ulna, there is distinctive and extraordinary anatomy in the distal humerus and distal humerus fractures is freely difficult that deliver reconstructive problems and difficulties such as damage to the blood vessels and nerve, these fractures are hard for orthopaedic surgeon to treat. Numerous establishments have established anatomically base precontoured condoyle plate system that can help with fracture decrease (Trotter and Gleser, 1953).

In olecranon fossa certain changes were establish in the average value of the height. The variation in the entire length of humerus as related to previous research happening as a result certain elements like race, age, sex, and environmentally friendly aspects disturbing growth bones, like diet, physical change and genetic factors.

CONCLUSION

Morphometric measurements of humerus segments may vary with populations, based on the comparison between the current and the previous studies. These differences may be attributed to influences like gender, race, age, environmental, nutritional status and genetics. Furthermore, such diversities might be influenced the differences in the reference point that are used as criteria in the measurements as Deniz *et al.,* (2005); Shilpa *et.al*, (2010).

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