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A study on segments of humerus and its clinical importance

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Abstract
Background: The humerus is the both the largest bone in the arm and the only bone in the upper arm. Many powerful muscles that manipulate the upper arm at the shoulder and the forearm at the elbow are anchored to the humerus. Movement of the humerus is essential to all of the varied activities of the arm, such as throwing, lifting, and writing. A humerus fracture is a break of the humerus bone in the upper arm. Fractures of the humerus may be classified by the location into proximal region, which is near the shoulder, the middle region, and the distal region, which is near the elbow. These locations can further be divided based on the extent of the fracture and the specific areas of each of the three regions affected. For better understanding the humerus facture the segmental morphometry is important.
Materials and Methods: The materials for the present study included 200 adult dry humeruses of unknown sex and obtained from various medical colleges from Karnataka. The morphometric details of different humerus segments viz. Maximum length of humerus, Mean distances between the articular segment of the humeral head and the greater tuberosity of humerus, Mean distance between caput humerus and callum of humerus, Mean distance between proximal and distal point of olecrane of humerus, Mean distance between distal part of olecrane process and trochlea of humerus, Mean distance between proximal edge of olacrane fossa and proximal part of trochea of humerus were carried out using Vernier callipers.
Results: The results were, maximum length of humerus was 302.8±25.6mm on right and left was 296.75±19.6mm, the mean distances between the articular segment of the humeral head and the greater tuberosity was 6.7±1.5mm on right and 7.5±1.6mm on left, between caput humerus and callum anatomicum was 40.8±7.8mm on right and 40.3±8.2mm on left, between proximal and distal point of olecrane fossa was 39.6±2.3mm on right and 41.1±2.9mm on left, between distal part of olecrane process and trochlea of humerus was 22.6±1.3mm on right and 21.7±1.8mm on left and between proximal edge of olacrane fossa and proximal part of trochlea of humerus was 24.12±2.3mm on right and 26.92±2.2mm on left.
Conclusion: The present study findings helps in orthopaedic surgery practice, for the treatment of proximal and distal humerus fractures and for their reconstruction.

Keywords: Humerus, Long bones, segments, fractures

Introduction
Though much advancement in science has been done, but estimating the stature of the individual from bones and as well as reconstructions of life from the human skeletal still remains a challenge for many anthropologists and forensic experts. Statures estimated from the human skeletal remains is an important step in assessing health and general body size trends among the given populations and also have an important role in the identification of missing persons in to medico-legal investigations [1,2]. In the absence of pelvis and cranium, morphometric analysis is frequently carried out on the remains of the long bones of the individual in anthropology and forensic science investigations and femur and tibia of the lower limb collectively remains the best for the assessment of living stature of the individual However in their absence, estimation of living stature can also be done from the long bones of the upper limb viz. Humerus, radius & ulna. For this purpose, either humerus can be used alone or collectively with other bones of upper limbs for the determination of sex and the estimation of stature of an individual [3, 4, 5].

Depending on Munoz *et al* [6] 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 [7]. In terms of repeatability, data evolution, objectivity and applicability to both cranial and post cranial the morphometric methods are most considered [8]. 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 [9]. The present study is conducted for morphometric analysis of humerus segments.

Materials and Methods

200 dry adult human humeruses constituted the material for the present study. The humeruses belong to the Karantaka region, India. Institutional ethical clearance obtained. Each was studied for the humerus segmental morphometric analysis. The following measurements were observed for this study.

- Maximum length of humerus
- Mean distances between the articular segment of the humeral head and the greater tuberosity of humerus
- Mean distance between caput humerus and callum of humerus
- Mean distance between proximal and distal point of olecrane of humerus
- Mean distance between distal part of olecrane process and trochlea of humerus
- Mean distance between proximal edge of olacrane fossa and proximal part of trochlea of humerus.

Results

The results were, maximum length of humerus was 302.8±25.6mm on right and left was 296.75±19.6mm, the mean distances between the articular segment of the humeral head and the greater tuberosity was 6.7±1.5mm on right and 7.5±1.6mm on left, between caput humerus and callum anatomicum was 40.8±7.8mm on right and 40.3±8.2mm on left, between proximal and distal point of olecrane fossa was 39.6±2.3mm on right and 41.1±2.9mm on left, between distal part of olecrane process and trochlea of humerus was 22.6±1.3mm on right and 21.7±1.8mm on left and between proximal edge of olacrane fossa and proximal part of trochlea of humerus was 24.12±2.3mm on right and 26.92±2.2mm on left (Table 1).

Table 1: The measurements of five different segments of humerus

	Parameter	Right(mm)	Left(mm)
1	Maximum length of humerus	302.8±25.6	296.75±19.6
2	The mean distances between the articular segment of the humeral head and the greater tuberosity	6.7±1.5	7.5±1.6
3	The mean distances between caput humerus and callum anatomicum	40.8±7.8	40.3±8.2
4	The mean distances between proximal and distal point of olecrane fossa	39.6±2.3	41.1±2.9
5	The mean distances between distal part of olecrane process and trochlea of humerus	22.6±1.3	21.7±1.8
6	The mean distances between proximal edge of olacrane fossa and proximal part of trochlea of humerus	24.12±2.3	26.92±2.2

Discussion

The humerus is the longest and largest bone of the upper limb and it is very important to identify its total length from their segmental measurements. In forensic anthropology, a method for estimating height based on the distances of segments of long bones becomes crucial and necessary. It has been shown that in forensic and archaeological studies, the mean value of total humerus length gives an important evidence to indicate the characteristic features of a population as a whole. In present study we were recorded mean values of the maximum humerus length of the adult humerus in Indian population, on both sides. It was 302.8±25.6mm on right and 296.75±19.6mm on left. In Somesh M. S *et al* study [10] it was found to be 309.6+20.6 & 299.6 + 22.5 mm on the right and left side, in Akman etal [11] same measurement found to be 307.1+ 20.6 & 304 ± 18.9 in Turkish population. Also, there is a possible existence of differences within the Caucasian populations, since Bulgarians have greater whereas the Maya forensic samples have lower mean values than Turks [10, 12].

In our study the mean distances between the articular segment of the humeral head and the greater tuberosity was 6.7±1.5mm on right and 7.5±1.6mm was on left, according to Green & Izzi [13] study was reported that the highest point on the articular segment of the head of the humerus is about 6 to 8 mm above from the most proximal point on the greater tuberosity and this relationship is important because the relative height of the greater tuberosity determines the amount of subacromial clearance as the arm is elevated and for the treatment of isolated greater tuberosity fractures. In study Somesh *et al* [10] this distance was 5.95 ± 1.18 mm and 5.83 ± 1.57 mm on right and left side respectively, in studies of Akman *et al* [11], Green & Izzi [13], Iannotti *et al* [14] and S. D. Desai *et al* [15] also found similar results. So, the measurement of these proximal humeral segments becomes important in cases of proximal humeral fractures, which extends along the epiphyseal lines of the proximal humerus and its segments, causing their displacement to various degrees.

In our study the mean distances between caput humerus and callum anatomicum found as 40.8±7.8mm on right and 40.3±8.2mm on left. According Rommens *et al* [16] fractures of the distal segments of the humerus involving olecranon can occur as a result of hyperextension trauma to the elbow joint. In study of Somesh *et al* [10] assessed that the distance from the proximal margin of the olecranon fossa to the distal trochlea was found to be 37.26 ± 4.71 mm on right humerus & 35.72 ± 4.30 mm on left humerus and in contrast these values were much less as compared to the Akman *et al* [11] Turkish population study found to be 24.2 ± 2.07 mm and 23.9 ± 2.63 mm on the right and left humerus respectively.

In present study the mean distances between proximal and distal point of olecrane fossa found to be 39.6±2.3mm on right and 41.1±2.9mm on left. In an archaeological study of Churchill & Smith[17] the distance between the proximal and distal edge of olecranon fossa was 20.2 ± 1.9mm for females and for males as 20.3 ± 1.3 mm.

In present study the mean distances between distal part of olecrane process and trochlea of humerus found to be 22.6±1.3mm on right and 21.7±1.8mm on left. In study Wright & Vásquez[18] the distance between the distal margin of the olecranon fossa and trochlea on the right humerus was

14.2 ± 1.8mm for males, in study of Somesh *et al* [10] the same measurement was found to be 17.37 ± 3.36 mm and 16.82 ± 2.20 mm on right and left humerus respectively. The distal segment of the humerus articulates with the bones of the forearm and fractures involving it may pose several reconstructive problems and complications. According to Jupiter and Mehne [19] these fractures gain special attention for orthopaedic surgeons.

In conclusion, morphometric analysis suggests that there are some differences between the segments of humerus within different population groups. Also when compared to Turkish population alone, there was an overall decrease in the mean values of all the humeral segments in Indian population and in some segments, it is possible to estimate maximum length of the humerus with relative accuracy. This study creates perspectives not only to forensic investigations, because the estimate could be extended to living height of individuals, but also in archaeological material, considering similarities of the proportions about fragments of long bones [10].

In previous studies authors did not analyse possible differences among population related to relationship between total humeral length and the measurements of their segments. Nath [20] method appreciated for regression analysis to define relationships between length of long bones and living height of individuals and as well as between the length of bones fragments and their maximum length according to Steele [21] the height of living individuals is variable measurements may be influenced by different factors such as ethnicity, age, sex, race and culture. The knowledge of humerus segment is very important for orthopaedic surgeons, anthropologists and forensic practice.

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