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ORIGINAL RESEARCH ARTICLE

Morphometric Study of the Lower End of Humerus in Dry Human Bones

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ABSTRACT

Background: The humerus is a major long bone of the upper limb and is important in orthopedic surgery, prosthetic design, and reconstructive procedures. Detailed morphometric data of its distal end are useful for surgical planning and implant selection.

Aim: To study the morphometric features of the lower end of the humerus using dry human bones.

Materials and Methods: A total of 100 dry humeri (50 right and 50 left) of unknown age and sex were examined. Measurements were taken using a vernier caliper. Three parameters were measured: (1) distance between proximal and distal articular surfaces of the olecranon fossa, (2) distance between the proximal articular surface of the olecranon fossa and the trochlea, and (3) maximum breadth of the distal humerus.

Results: The mean distance between proximal and distal articular surfaces of the olecranon fossa was 39.78 ± 2.8 mm (right) and 38.62 ± 3.6 mm (left). The mean distance between the proximal articular surface of the olecranon fossa and the trochlea was 21.32 ± 1.3 mm (right) and 21.39 ± 1.2 mm (left). The maximum breadth of the distal humerus was 56.8 ± 1.9 mm (right) and 55.4 ± 2.2 mm (left). No statistically significant difference was found between right and left sides ($p > 0.05$).

Conclusion: The present study provides reliable morphometric data of the distal humerus that can be useful to orthopedic surgeons, prosthetic designers, and anatomists. The findings support the use of the contralateral limb as a reference during surgical reconstruction.

Keywords: Humerus, Morphometry, Olecranon fossa, Trochlea, Distal humerus, Anatomy

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INTRODUCTION

The humerus is the long bone of the arm and forms the skeletal framework of the upper limb. Its distal end articulates with the radius and ulna to form the elbow joint, which allows flexion, extension, pronation, and supination. The elbow is a complex joint and its normal function depends on the precise anatomy of the distal humerus.[1,2]

Fractures of the distal humerus are common and are seen in all age groups, often due to falls, road traffic accidents, and osteoporosis. Surgical treatment such as open reduction and internal fixation (ORIF) and total elbow arthroplasty requires a thorough understanding of local bone anatomy. Implants and fixation devices designed without adequate anatomical data may lead to poor surgical outcomes.[3,4]

Morphometric studies provide quantitative data on bone dimensions and are helpful in clinical practice, forensic identification, anthropological research, and prosthetic design. In recent years, such data have also become important for computer-assisted surgery, three-dimensional (3D) modeling, and artificial intelligence (AI)-based surgical planning systems.[5,6]

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Several morphometric studies on the humerus have been published, but many of them focus on the whole bone rather than the distal end specifically. Furthermore, bone dimensions vary across populations due to differences in

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genetics, nutrition, and physical activity. It is therefore important to generate population-specific data that can be applied locally in clinical settings.[7,8]

The present study was conducted to measure the key morphometric parameters of the distal end of the humerus using dry human bones. The aim is to provide reliable and accurate data that can support orthopedic surgeons, prosthetic designers, and anatomists in their clinical and academic work.

MATERIALS AND METHODS

Study Design and Setting

This was a descriptive, cross-sectional morphometric study conducted in the Department of Anatomy, Gandhi Medical College. The study was carried out over several months using dry human humeri from the osteological collection of the department.

Study Sample

A total of 100 dry human humeri were included, comprising 50 right-sided and 50 left-sided bones. The bones were of unknown age and sex, as is typical for osteological collections used for research. Only well-preserved adult bones without visible deformities were selected.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Intact dry human humeri
- Fully ossified adult bones
- Bones without any visible deformity or damage

Exclusion Criteria

- Broken or fragmented bones
- Bones with deformities, erosion, or pathological changes
- Bones with unclear anatomical landmarks

Parameters Measured

The following three parameters of the distal humerus were measured

- Distance between the proximal and distal articular surfaces of the olecranon fossa
- Distance between the proximal articular surface of the olecranon fossa and the proximal part of the trochlea
- Maximum breadth of the distal end of the humerus (measured between the medial and lateral epicondyles)

Measurement Technique

All measurements were taken using a standard vernier caliper with a least count of 0.01 mm. Relevant bony landmarks were identified visually and confirmed by palpation before each measurement. To reduce observer error, each measurement was taken twice and the average value was recorded. The same observer carried out all measurements under standardized conditions [9,10]

Statistical Analysis

Data were recorded in a pre-designed proforma and expressed in millimeters (mm). Descriptive statistics, including mean and standard deviation (SD), were calculated for each parameter. Comparison between right and left sides was done using Student's unpaired t-test. A *p-value* of less than 0.05 was considered statistically significant. Statistical analysis was performed using SPSS version 26.0.

Ethical Considerations

The study was conducted on dry human bones obtained from the departmental collection and did not involve living subjects. Therefore, formal ethical clearance was not required. All institutional guidelines for handling and studying human skeletal material were strictly followed.

RESULTS

Morphometric analysis was performed on 100 dry human humeri (50 right, 50 left). The three parameters measured were the proximal-distal olecranon fossa distance, the olecranon fossa-to-trochlea distance, and the maximum breadth of the distal humerus. Results are presented as mean ± SD in Table 1.

The mean proximal-distal olecranon fossa distance was slightly greater on the right side (39.78 mm) compared to the left (38.62 mm). The olecranon fossa-to-trochlea distance was nearly identical on both sides (right: 21.32 mm, left: 21.39 mm), indicating good bilateral symmetry. The maximum breadth of the distal humerus was slightly more on the right (56.8 mm) compared to the left (55.4 mm).

Table 1: Morphometric measurements of the distal humerus (mean ± SD in mm)

Parameter	*Right (Mean ± SD)*	*Left (Mean ± SD)*
Proximal–Distal Olecranon Fossa Distance (mm)	39.78 ± 2.8	38.62 ± 3.6
Olecranon Fossa–Trochlea Distance (mm)	21.32 ± 1.3	21.39 ± 1.2
Maximum Breadth of Distal Humerus (mm)	56.8 ± 1.9	55.4 ± 2.2

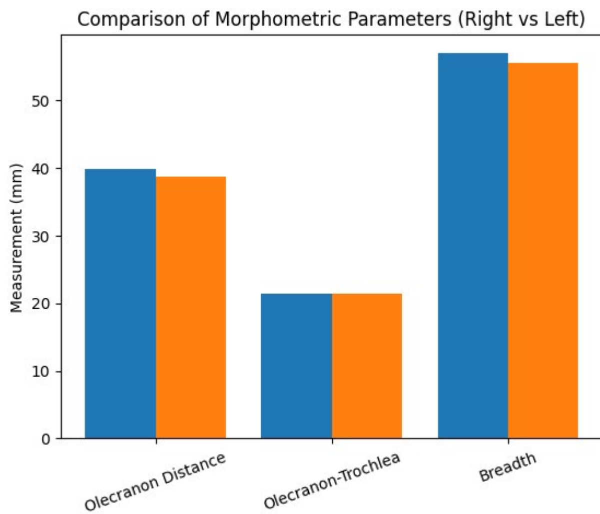

Figure 1: Bar diagram showing comparison of morphometric parameters

Comparison between right and left sides using Student's unpaired t-test showed no statistically significant difference ($p > 0.05$) for any of the three parameters. This finding confirms the bilateral symmetry of the distal humerus in the study sample.

DISCUSSION

The present study evaluated three morphometric parameters of the distal humerus using 100 dry bones. The findings were comparable with those of earlier studies from India and other countries, confirming the reliability of the data.

The mean proximal-distal olecranon fossa distance (39.78 mm right, 38.62 mm left) was similar to values reported by Prasad NC *et al*. and Pandey *et al*.[1,7] This measurement has significance in fracture fixation at the distal humerus, as surgical implants must match local bone dimensions to achieve stable fixation and good functional recovery.

The olecranon fossa-to-trochlea distance showed almost equal values on both sides (21.32 mm right, 21.39 mm left), which is in agreement with findings of Akman *et al*. and Somesh *et al*.[2,5] Precise restoration of this distance during elbow reconstruction is important for maintaining joint congruency and normal range of motion. Any deviation may lead to restricted movement or joint instability.

The maximum breadth of the distal humerus (56.8 mm right, 55.4 mm left) was comparable to data published by Sinha *et al*. and Lokanadham *et al*.[7,8] This measurement is particularly relevant for the design and selection of elbow implants. An implant that closely matches the native bone dimensions is associated with better surgical outcomes and fewer complications such as loosening or malalignment.

The absence of any significant side-to-side difference is an important finding. It suggests that in clinical situations where one limb is injured and anatomical landmarks are distorted, the opposite limb can be used as a reliable reference for reconstruction. This is especially useful in cases of comminuted distal humeral fractures.[3,4]

Population-specific morphometric data are important because bone dimensions vary across different ethnic groups due to differences in genetics, nutrition, and physical activity levels.[5,6] Studies conducted on Western populations may not be directly applicable to Indian patients. The present study contributes regional data that can help improve the accuracy of surgical planning and implant selection in India.

Beyond clinical surgery, morphometric data from long bones are also used in forensic science and anthropology to estimate age, sex, and stature from skeletal remains.[11,12] While the primary focus of the present study is on clinical application, the data generated may also be of value in these fields.

In recent years, advances in computer-assisted surgery, 3D printing, and AI-based surgical planning have increased the demand for precise and population-specific anatomical data.[13] Morphometric measurements serve as important inputs for developing patient-specific implants and surgical templates. The present data can contribute to such applications.

The main limitations of this study are the unknown age and sex of the specimens and the absence of radiological correlation. Future studies should include larger sample sizes with known demographic details and use imaging modalities such as CT scanning for more detailed analysis. Comparative studies across different Indian populations will further improve the applicability of morphometric data in clinical practice.

CONCLUSION

The present study provides morphometric data of the distal humerus from 100 dry human bones. The measurements were consistent across the right and left sides, confirming bilateral symmetry. No statistically significant side difference was observed for any parameter. The data obtained are reliable and in agreement with published literature. These findings can assist orthopedic surgeons in surgical planning, help prosthetic designers in implant development, and contribute to anatomical databases relevant to the Indian population. The bilateral symmetry of the distal humerus supports the clinical practice of using the opposite limb as a reference during reconstruction procedures.

LIMITATIONS

Age and sex of the specimens were unknown, which limits demographic analysis.

Regional variation may affect the generalisability of the findings

Sample size, though adequate, can be expanded in future studies for broader applicability

Radiological correlation was not included in the present study

FUTURE SCOPE

Future studies should include larger sample sizes with known demographic details, radiological correlation using CT scans, and comparisons across different regional populations. Integration of morphometric data with biomechanical analysis and 3D modeling will further improve its clinical utility.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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