

Original Research Article

Anthropometric evaluation of the olecranon coronoid angle in the North Indian population for sex identification

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ABSTRACT

Background: The olecranon-coronoid angle, a significant anatomical parameter in the proximal ulna, is increasingly being studied as a potential indicator of biological sex in skeletal remains. This study investigated the morphometric variability of this angle in the north Indian population, aiming to establish its utility as a reliable sex indicator. The data thus obtained were tabulated, scrutinized, analyzed, and compared with the earlier studies wherever possible. By analyzing a sample of adult ulnae, the study provided insights into population-specific differences and their implications for forensic anthropology and bioarcheology. If any variant from the normal was observed, an attempt has been made to explain the same.

Methods: A cross-sectional morphometric study was conducted on 100 dry, intact adult ulnae (right and left) of known sex. These 100 adult human ulnae were obtained from embalmed cadavers used for dissection in the Department of Anatomy, Government Medical College, Amritsar, and formed the material for the current study. Data were statistically analyzed using SPSS.

Results: In the study of 100 ulnae (M:F- 50:50), the olecranon coronoid angle was determined to be $22.56^{\circ} \pm 3.32$ in males and $15.71^{\circ} \pm 4.39$ in females.

Conclusions: The olecranon-coronoid angle exhibits significant sexual dimorphism, and its measurement is helpful in reconstruction of elbow disorders observed after treatment of distal humerus fractures. The primary objective of applying anthropometric methods in anatomy and forensic medicine is to assist law enforcement agencies in establishing the personal identity of unknown human remains.

Keywords: Coronoid process, Olecranon-coronoid angle, Trochlear notch, Ulna

INTRODUCTION

Morphology has been described as the soul of anatomy. Amongst bones the form and morphometric parameters of ulna have always invoked a keen interest not only to the anatomist but also to the anthropologist, the forensic expert and the clinicians for stature estimation, assessment of age, sex determination and for treatment purposes.

Sex estimation from skeletal remains is the first and most critical step in forensic anthropology and medicolegal investigations, as it reduces the pool of possible identities by half. While the pelvis and skull provide the highest accuracy (95-100% and 80-90% respectively), postcranial bones such as the ulna, femur, and tibia also play an essential role, especially when skeletal remains are incomplete or fragmented.¹⁻³ The ulna has gained prominence due to their availability and robust nature. Long, prismatic and the stabilizing bone of the forearm with its trochlear notch gripping the lower end of

humerus.⁴ The obliquity of the superior articular surface of coronoid process, not set at right angle to the shaft of ulna. This accounts for the formation of the carrying angle of the elbow. The role of 'carrying angle' in sex determination and its cause of formation is a long-debated issue in two 'A's, anatomy and anthropology. Identification of sex from skeleton parts is of paramount importance to medicolegal investigations. Determination of sex from human skeletal fragments plays an important role in establishing the identity of any individuals.⁵ Physical examination gives only a rough idea but to be precisely accurate in the identification, the metrical methods are indispensable.⁶

Sex is considered as one of the easiest determinations from the skeletal material and one of the most reliable if essential parts of the skeleton are available in good condition.¹ Although several Indian and international studies have explored ulna morphometry for sex determination, research specifically targeting the olecranon–coronoid angle in the north Indian population remains limited. This study aimed to analyze this parameter and evaluate its reliability as a sex indicator.

Aims and objectives

To examine the typical and variant anatomy of the olecranon-coronoid angle of the ulna within the north Indian population. To compile and systematically analyze the results, providing baseline data for each sex. To compare the findings with available literature and assess the potential clinical implications of observed anatomical variations.

METHODS

The study protocol was approved by the institutional ethics committee (number: 4586/D-26/2009 Date: 25/02/2021). The study was conducted in accordance with the principles of institutional ethical committee.

Study design

A cross-sectional morphometric study was undertaken, utilizing 100 dry, intact adult ulnae of known sex, collected over the period from 2019 to 2020. These 100 ulnae (M:F- 50:50) obtained from the department of anatomy, Government Medical College, Amritsar.

All ulnae were without any gross abnormality. Dried ulnae labeled from 1 to 100 with suffix M (male) or F (female).

Inclusion criteria

Dry, macerated and thoroughly cleaned ulnae were included in the study. These were the adult ulnae of either side. Each ulna was examined to make sure that there has occurred a complete fusion of epiphysis of upper and lower end.

Exclusion criteria

The ulna incomplete in any respect or any variable anatomical feature seen in bone were excluded from the study.

Olecranon-coronoid angle

The ulna was placed with its medial surface in contact with the board. The bone was placed on the board in such a position that the point projecting most posterior on the styloid process touched the lateral wall of the board. The thread was adjusted to lie parallel to the line joining upper lip of the olecranon process and beak of coronoid process. The angle was measured between lateral wall of the board as a base and a thread joining the line, extended to meet base line (Purkait). The angle was measured with protractor ($\angle AOB$ in Figure 1).

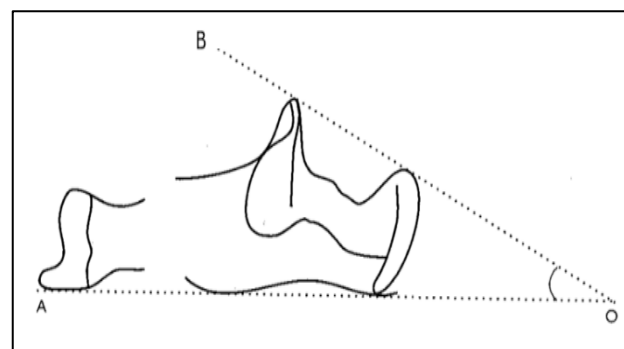


Figure 1: Ulna viewed from a lateral aspect showing the olecranon coronoid angle.

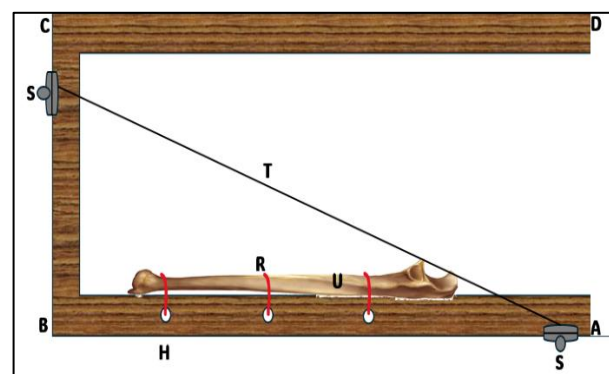


Figure 2: Apparatus description.

ABCD is a 50×30 cm rectangular board provided with a side wall of 3 cm height on all sides except for side AD. The AB side has been provided with 4 mm diameter holes at 3 intervals where ulna is approximated with the help of rubber bands (H-Hole, R- Rubber, U- Ulna, T-Thread, S-Slider).

Data obtained was entered into Microsoft Excel and analyzed using SPSS. Descriptive statistics including mean, standard deviation, and range were calculated for each variable. The independent samples Student's t-test was employed to compare the olecranon-coronoid angle between males and females. Discriminant function

analysis was then applied to derive a predictive equation for sex determination, and its classification accuracy was assessed.

RESULTS

The average olecranon coronoid angle in the current study was determined to be $22.56^{\circ} \pm 3.32$ in males and $15.71^{\circ} \pm 4.39$ in females. As a result, the male ulna has a higher angle value than the female. The difference was shown to be statistically significant ($p=0.006$) as in Table 1.

Table 1: Statistical results of olecranon coronoid angle of the ulna.

Population	No.	Mean $\pm$ SD (degree)	Range (degree)	p value
North Indian	50	M 22.56 $\pm$ 3.32	17-30	0.006 (S)
	50	F 15.71 $\pm$ 4.39	14-30	0.006 (S)

Comparison of olecranon coronoid angle in males and females

A visual comparison was made of the olecranon coronoid angle between male and female subjects. This graphical representation highlights the observed differences in the measured angles, serving as a foundational aspect for further discussion and analysis in the context of sexual dimorphism of the ulna.

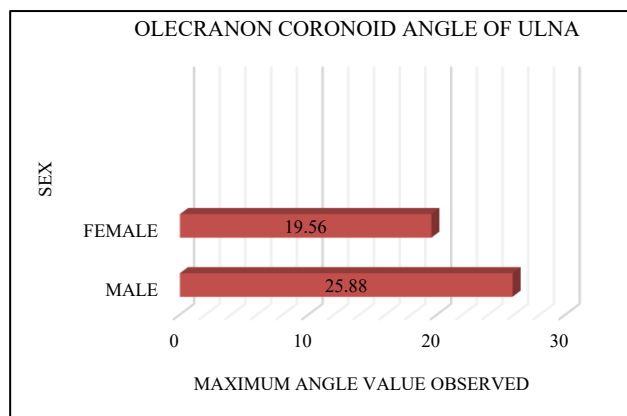


Figure 3: Comparison of olecranon coronoid angle in males and females.

DISCUSSION

Anthropometry involves systematic measurement of the human body and skeletal structures. It is widely utilized within biological anthropology and holds significant

importance in the fields of anatomy and forensic medicine. When applied by skilled professionals, anthropometric techniques provide highly reliable data essential for research, identification, and medical applications.

The study had been undertaken to identify the sexually dimorphic feature of ulna bone. As early as 1957 Godyeki, followed by Neto studied the sigmoid notch of ulna and attempted to assess sex, based on groove dividing the notch.^{7,8} Purkait gave a view that the accuracy of single variable of ulna, the olecranon coronoid angle could classify the maximum number of bones into male and female with accuracy of 85%.⁹ So, he concluded that the ulna might prove equally effective in sexing populations. Purkait et al made measurements of olecranon coronoid angle.⁵ By statistical analysis of ulnar data, they observed that the male ulna exhibits greater value for angle and dimensions than female as in present study. Last stated that obliquity of shaft of ulna to the line joining the prominences of olecranon and coronoid processes play role in formation of carrying angle.¹⁰ As suggested by William et al, fact is that the upper end of ulna set at an angle with the long axis of the shaft, and this come in to play when the arm is extended and olecranon process fit into fossa.¹¹ He also commented, the medial edge of trochlea of humerus partly responsible as it projects nearly 6 mm below the lateral edge. According to Mall, the axis of elbow joint is set obliquely at nearly 84° to both the humerus and ulna, also agreed upon by Jones.^{12,13} Langer was of opinion that the obliquity of the trochlea to the shaft of humerus is a cause of carrying angle.¹⁴ Kapandji explained that the angle is formed because of trochlear groove being vertical anteriorly but on the posterior aspect it runs obliquely, distally and laterally.¹⁵ This results in formation of carrying angle in extension when posterior aspect of the oblique groove contacts the trochlear notch of ulna and the angle is marked during flexion when trochlear notch lies on the vertical groove in the anterior aspect. Krishan et al highlighted the usefulness of ulna morphometry in a North Indian cohort, particularly maximum length and olecranon breadth, for distinguishing sex.² Mall et al measured various anthropometric dimensions of humerus, ulna and radius to determine sex by using discriminant analysis.¹⁶ They concluded that radius (94.93%) is the best bone for sex determination, followed by humerus (93.15%) and ulna (90.58%). Badkur and Nath used eleven measures from 288 ulnae (from 82 male and 62 female skeletons) to create linear and multilinear regression models for estimating ulnar length and stature.¹⁷ The results revealed minimal bilateral variance but considerable sex differences. The breadth of the olecranon provided the most accurate indication of height, whereas the upper shaft circumference best predicted ulnar length.

Table 2: Statistical comparison of olecranon coronoid angle of the ulna.

Authors	Population	No.	Mean±SD (degree)	Range (degree)	P value
Purkait et al⁴	Indians Madhya Pradesh)	100	M 22.26±3.47	-	<0.001 (HS)
		60	F 14.73±4.46	-	<0.001 (HS)
Purkait et al⁴	Indians (Madhya Pradesh)	100	M 22.26±3.47	-	<0.001 (HS)
		60	F 14.73±4.46	-	<0.001 (HS)
Present study	North Indians	50	M 22.56±3.32	17-30	0.006 (S)
		50	F 15.71±4.39	14-30	0.006 (S)

Comparison of olecranon-coronoid angle in different studies

This section highlights the observed differences and trends in the olecranon-coronoid angle across a variety of studies. The significance of the angle as a sexually dimorphic trait is further supported by comparison analysis, which makes it clear how measurements vary by sex, range. These comparisons are crucial for improving the forensic and anthropological usefulness of this anatomical trait and expanding our understanding of it across a range of populations.

The study primarily focused on the olecranon-coronoid angle as a sexually dimorphic feature. While this angle is significant, relying on a single variable may limit the comprehensiveness of the findings. Other anatomical features and variables could provide additional insights into sex determination. Larger multicentric studies across different populations are required for establishing standardized reference ranges.

CONCLUSION

The olecranon-coronoid angle exhibits significant sexual dimorphism in the North Indian population, making it a valuable morphometric trait for sex determination. While not definitive, it can complement other osteological methods in forensic and anthropological contexts. Advantage of measuring olecranon coronoid angle can be taken on fragmentary skeletal remains where only upper end is available. Knowledge of the measurement of the elbow carrying angle and of its variations is important in evaluating traumatic elbow injuries and other elbow disorders that require reconstruction or arthroplasties.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee (number: 4586/D-26/2009 Date:25/02/2021)

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