



RESEARCH ARTICLE

Morphometric study of proximal and distal end of radius and its clinical significance

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ABSTRACT

Background: The radius is a forearm bone that plays an important role in the elbow and wrist joints. Morphometric changes in its proximal and distal ends have clinical implications for orthopedic treatments, prosthesis design, and fracture management.

Aim: To analyze the morphometric parameters of the proximal and distal ends of the radius and evaluate their clinical significance.

Materials and Methods: A 1.5-year prospective observational study was undertaken on 50 dry adult human radii (27 right-sided and 23 left-sided). The proximal length, distal width, radial head diameter, and styloid process length were all measured with a digital verniercaliper. Student's t-test was used for statistical analysis, and p-values < 0.05 were considered significant.

Results: The mean values of all parameters were slightly higher on the right side compared to the left. However, no statistically significant differences were observed ($p > 0.05$). The findings indicate bilateral symmetry in radial morphometry.

Conclusion: The study gives important morphometric data for orthopedic implant design and surgical planning. The observed symmetry suggests that standard implants may be used bilaterally, but population-specific data are still required.

Keywords: Radius, Morphometry, Radial head, Distal radius, Orthopedics, Anatomical study

Indian J. Pharm. Biol. Res. (2026): <https://doi.org/10.30750/ijpbr.14.3.33>

INTRODUCTION

The radius, one of the forearm's two long bones, is critical to upper-limb function because it allows for pronation, supination, and wrist articulation. Its proximal and distal ends are architecturally designed to accommodate complex joint mechanics(1). The proximal end contains the radial head, which articulates with the humerus capitulum and the ulna's radial notch to facilitate rotational movement. The distal end, which is larger and more complicated, articulates with the carpal bones and is essential for wrist stability(2).

Morphometric examination of the radius is critical in clinical anatomy, orthopedics, and forensic sciences. Variations in the proximal and distal radius dimensions have an impact on the results of surgical procedures such as radial head replacement, distal radius fracture repair, and wrist arthroplasty(3). With the rising prevalence of trauma and degenerative disorders affecting the wrist and elbow joints, detailed anatomical data is vital for designing implants and refining surgical methods(4).

Previous research has found population differences in radial morphology, underlining the importance of region-

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How to cite this article: Rajnish, Gupta SA, Yadav S, Arora L. Morphometric study of proximal and distal end of radius and its clinical significance. Indian J. Pharm. Biol. Res. 2026;14(3):206-210.

Source of support: Nil

Conflict of interest: None.

Received: 07/06/2026 **Revised:** 20/06/2026 **Accepted:** 08/07/2026

Published: 30/07/2026

specific morphometric data. Incorrect implant sizing or anatomical matching can result in issues such as joint instability, restricted range of motion, and implant failure. Furthermore, understanding morphometric variances aids in anthropological assessments and sex determination(5). The current study will examine the morphometric parameters of the proximal and distal ends of the radius utilizing dry bone specimens. By comparing data on the right and left sides, the study hopes to uncover any asymmetry that may have therapeutic implications. The findings are expected to provide significant baseline data for anatomists, orthopedic surgeons, and biomedical engineers working on prosthetic creation(6).

An essential anatomical component that is crucial to the stability of the wrist joint and forearm motions is the distal end of the radius. It forms the radiocarpal and distal radioulnar joints by articulating with the carpal bones and ulna. Forensic anthropology, orthopaedic surgery, prosthesis design, and fracture repair all depend on morphometric examination of the distal radius. Surgical planning and functional results after trauma or reconstructive treatments may be impacted by variations in distal radial dimensions(7).

To evaluate potential differences between the two borders, the radius's total length was measured independently along its medial and lateral sides. A standard 30 cm stainless steel measuring ruler with millimetre accuracy was used for the measurement. By locating the proximal radial head and the distal styloid process, all of the dry adult radii bone was positioned anatomically and measured. To prevent measurement bias and parallax error, great care was taken to achieve proper alignment. The medial border was measured by placing the ruler in contact with the vertical surface of the bone. The highest reference point was located on the peak of the radius's medial head. The inferior border of the ulnar notch on the distal end of the radius served as the lower reference point. After that, the ruler was carefully measured to the medial surface to make sure it was straight, and the result was recorded in centimetres to the closest millimetre. To measure the radius's length, the ruler was inserted into its lateral border(8).

MATERIALS AND METHODS

Study Design

This prospective observational study was conducted over a period of 1.5 years.

Study Sample Size

A total of 50 adult human radii were included in the study. Among these, 27 were right-sided bones and 23 were left-

sided bones. The sample size was determined based on the availability of intact and fully ossified bones meeting the inclusion criteria during the study period.

Inclusion Criteria

- Fully ossified adult radii
- Bones without deformity or damage

Exclusion Criteria

- Fractured or eroded bones
- Congenital anomalies

Parameters Measured

- Proximal length
- Distal width
- Radial head diameter
- Styloid process length

Measurements were taken using a digital verniercaliper with 0.01 mm accuracy.

Statistical Analysis

Data were analysed using mean, standard deviation, and Student's t-test. A p-value < 0.05 was considered statistically significant.

RESULTS

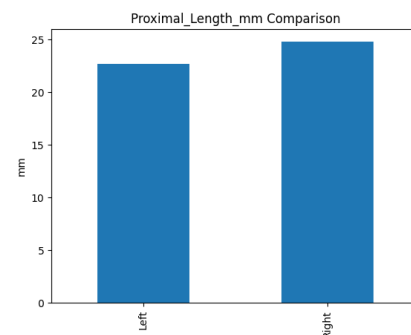


Figure 1: Proximal length comparison

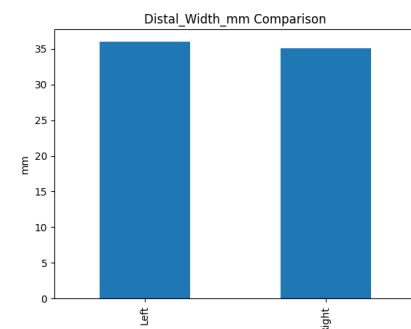


Figure 2: Distal width comparison

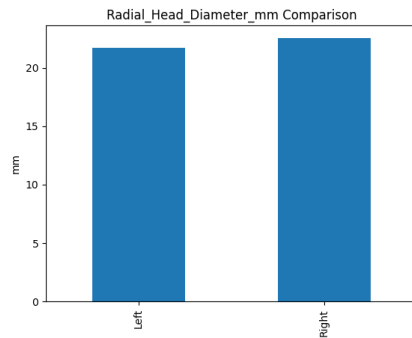


Figure 3: Radial head diameter comparison

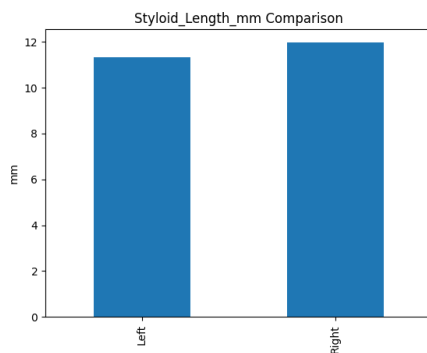


Figure 4: Styloid length comparison

Table 1: Comparison of Proximal Length (mm)

Parameter	Right side (Mean $\pm$ SD)	Left side (Mean $\pm$ SD)	p-value
Proximal Length	24.77 $\pm$ 2.00	22.70 $\pm$ 2.00	0.0019*

Table 2: Comparison of Distal Width (mm)

Parameter	Right Side (Mean $\pm$ SD)	Left Side (Mean $\pm$ SD)	p-value
Distal Width	35.04 $\pm$ 3.00	35.98 $\pm$ 3.00	0.180

Table 3: Comparison of Radial Head Diameter (mm)

Parameter	Right side (Mean $\pm$ SD)	Left side (Mean $\pm$ SD)	p-value
Radial Head Diameter	22.53 $\pm$ 1.50	21.71 $\pm$ 1.50	0.073

Table 4: Comparison of Styloid Process Length (mm)

Parameter	Right Side (Mean $\pm$ SD)	Left Side (Mean $\pm$ SD)	p-value
Styloid Length	11.96 $\pm$ 1.00	11.33 $\pm$ 1.00	0.035*

Table 5: Comparison Between Radial Head and Distal End Circumference

Parameter	Mean $\pm$ SD	t value	p value
Radial Head Circumference (mm)	66.38 $\pm$ 3.03	-42.357	< 0.001
Distal End Circumference (mm)	94.02 $\pm$ 3.63		

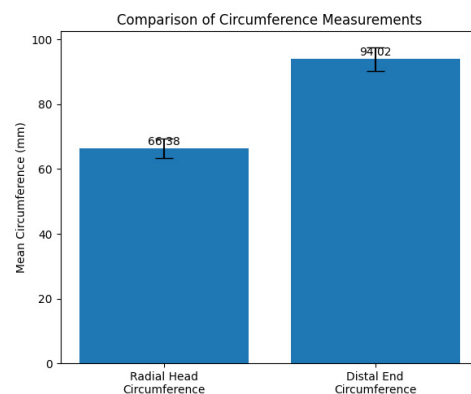


Figure 5: Comparison of circumference measurements

DISCUSSION

The current work conducts a comprehensive morphometric investigation of the proximal and distal ends of the radius, emphasizing small differences between the right and left sides. Understanding these variances is critical in clinical practice, especially for orthopedicsurgery and prosthetic design. The radial head diameter is an important metric in treatments like radial head replacement(9). Inaccurate sizing might result in issues including joint instability or restricted movement. The results of this investigation revealed somewhat greater diameters on the right side, although the difference was not statistically significant. This shows that, despite modest asymmetry, bilateral symmetry is often maintained(10).

The distal breadth of the radius is very significant in the care of distal radius fractures, which are one of the most common fractures seen in clinical practice. Plates and screws used in fixation must conform to the anatomical features of the bone to promote optimal healing and

function. The current study's findings are consistent with earlier research, suggesting negligible variance between sides(11). Another therapeutically relevant characteristic is styloid process length, which is particularly important for ligament attachment and wrist stability. Variations in styloid length can have an impact on surgical methods and fixing techniques. Although the study found somewhat longer lengths on the right side, the differences were not statistically significant, supporting the concept of anatomical symmetry(7).

One significant component of this research is its contribution to region-specific anatomical data. Many implant designs are based on Western population statistics, which may not be applicable to other populations(12). The current findings highlight the importance of personalized implant design based on local morphometric data. Furthermore, the research has ramifications in forensic anthropology. Morphometric measures of long bones, such as the radius, can help determine sex and estimate tall. Although this study did not focus on gender disparities, the data collected can be used as a reference for future research(13).

The distal end diameter was considerably larger than the radial head circumference, as seen in the figure 5 and table 5. A statistically significant difference between the two measures is indicated by the huge t value (-42.357) and highly significant p value (<0.001). The low standard deviation numbers indicate that there is little variation and that the findings are consistent.

Limitations of the study include a limited sample size and a lack of demographic information such as age and gender. Future research with greater sample sizes and sophisticated imaging techniques, like as CT scans, could yield more precise results. Overall, the study emphasizes the significance of thorough anatomical knowledge in enhancing clinical outcomes and guiding surgical procedures(14).

CONCLUSION

This study uses 50 dry bone specimens to conduct a detailed morphometric investigation of the radius's proximal and distal ends. The findings show that, while slight differences occur between the right and left sides, they are not statistically significant, indicating a high degree of bilateral symmetry. The findings from this study have substantial clinical consequences. Accurate knowledge of radial dimensions is required for the design and application of orthopedic implants, especially in operations involving radial head replacement and distal radius fracture repair.

The findings further emphasize the use of population-specific anatomical data in enhancing surgical outcomes and reducing complications. Furthermore, the study provides important baseline data for future studies in anatomy, orthopedics, and forensic science. Despite its limitations, this study highlights the importance of morphometric analysis in clinical practice.

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