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**Original Research Article**

# A STUDY OF MORPHOLOGY AND MORPHOMETRY OF PROXIMAL END OF DRY RADIUS BONES WITH ITS CLINICAL IMPLICATIONS

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## ABSTRACT

**Background:** Fracture of the radial head constitute 1/3rd of all the elbow fractures. It occurs as a result of a fall on an outstretched hand or a direct blow to the lateral aspect of elbow joint. This is now becoming more common due to pre existing co-morbidities like osteoporosis and chronic osteoarthritis. Surgical correction of the comminuted fractures of radial head involves reconstruction or replacement with artificial radial head prosthesis in cases where reconstruction is not possible.

**Aims and Objectives:** To analyze the morphometric details of proximal end of radius and to describe the morphological features of head and bicipital tuberosity of the radius.

**Materials & Methodology:** Sixty dry human adult radius bones of unknown age and sex were assessed for morphometric and morphological characters. Vernier caliper was used to measure the various parameters on the proximal ends of radius bones. The data was tabulated and analyzed using SPSS software.

**Results:** The mean length of radius was found to be 23.98 cm. Antero-posterior diameter and transverse diameter of head was 2.01 cm and 1.98 cm respectively. The height of radial head at medial end, height of radial head at lateral end, depth of articular facet and radial head circumference were 0.91 cm ,0.73 cm, 2.91 cm, 4.78 cm respectively. The length of neck of the radius, diameter of proximal end of neck of radius, diameter of distal end of neck of radius was 1.28 cm , 1.37 cm , 1.32 cm respectively. The width of bicipital tuberocity, length of bicipital tuberocity were 1.21 cm, 2.29 cm respectively.

**Conclusions:** Fractures of radial head and neck are more common. Surgical management of displaced and comminuted radial head fractures needs replacement with radial head prosthesis when reconstruction is not indicated. The results of our study are important in making anatomically and biomechanically suitable radial head prosthesis.

**KEY WORDS:** Fractures Of Radial Head, Bicipital Tuberosity, Head, Neck, Radius, Prosthesis.

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## INTRODUCTION

The proximal end of radius contributes in the formation of proximal radioulnar joint and humeroradial joint .The head of the radius plays a very important role in the elbow and wrist biomechanics and any fracture or resection of

radial head leads to unstability of the joints [1].

Radial head fractures accounts for approximately 1/3rd of all the elbow fractures and involved in 20% of elbow trauma cases. Radial head and neck fractures together constitute 1.7% to 5.4% of all fractures [2].

The operative treatment for proximal radial fracture with minimal comminuted fractures includes anatomical reconstructions with stable fixation to achieve early recovery of function. In communited fractures prosthetic radial head replacement is commonly recommended as an alternative to internal fixation to avoid complications like malunion, loosening and impingement of hardware in proximal radioulnar joint[3].

The accurate knowledge of size and shape of the head of radius is essential in construction of radial head prosthesis which is anatomically and biomechanically suitable for Indian population. The measurements of bicipital tuberosity and its angular relationship with radial head are significant in various surgical procedures like reconstruction of biceps tendon, radial head prosthesis implantation, and reconstruction of proximal radius trauma [4,5].

So, the purpose of this study was to document the morphometric parameters of proximal end of dry radii bone and to describe the morphological features of head and bicipital tuberosity of radius.

## MATERIALS AND METHODOLOGY

This cross sectional study was performed in Department of Anatomy, M S Ramaiah Medical College, Bangalore. 60 adult dry human radius (right = 37, Left= 23) bones of unknown gender and origin were taken for the study. The radius bones were numbered and labeled according to their side. A hand held magnifier was used for closer inspection. Vernier caliper was used for the accurate measurements. Osteometric board was used for measuring the length of the radius.

**Inclusion criteria**: normal adult dry radii bones

**Exclusion criteria**: abnormal/anomalous, damaged radii bones

**The following parameters were measured: ( Figures 1 & 2 )**

· Length of the radius(L): An osteometric board was used to measure the length of the radius from the tip of the styloid process to the most lateral portion of radial head.

**Radial head dimensions**

· Height of radial head was measured as the distance between the radial lip and the head-neck border at the medial(MH), ventral(VH), lateral(LH) and dorsal ends(DH)

· Anteroposterior diameter (APD) and transverse diameter(TD) of radial head

· Depth of articular facet(D) was measured using the depth probe of the vernier caliper.

· Different shapes of radial head.

**Radial neck dimensions**

· Length of neck(NL) of radius was measured from the head-neck junction to the most proximal border of bicipital tuberosity.

· Proximal and distal neck diameter (PND & DND) of radius were measured in antero-posterior plane.

**Bicipital tuberosity dimensions**

· Length, width of bicipital tuberosity (LBT & WBT)

· Variants of bicipital tuberosity. **( Figure 3)**

· Circumference of radius at bicipital tuberosity (CRBT)

The resultant measurements were statistically analyzed using the SPSS software.

**Fig. 1: a**- Length of radius, **b**- Length of the neck of radius , **c**- Transverse diameter of neck.

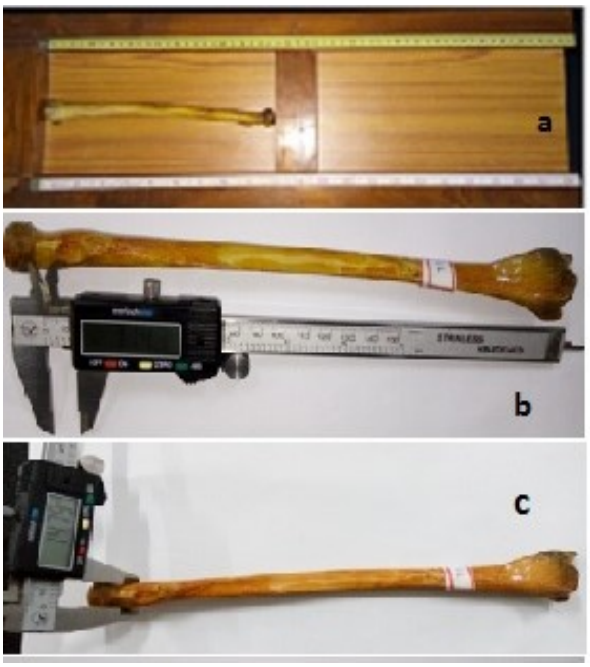


**Fig. 2:** d- Transverse diameter of the head , e- Height of the head , f- Round shape of head, g- Oval shape of head.

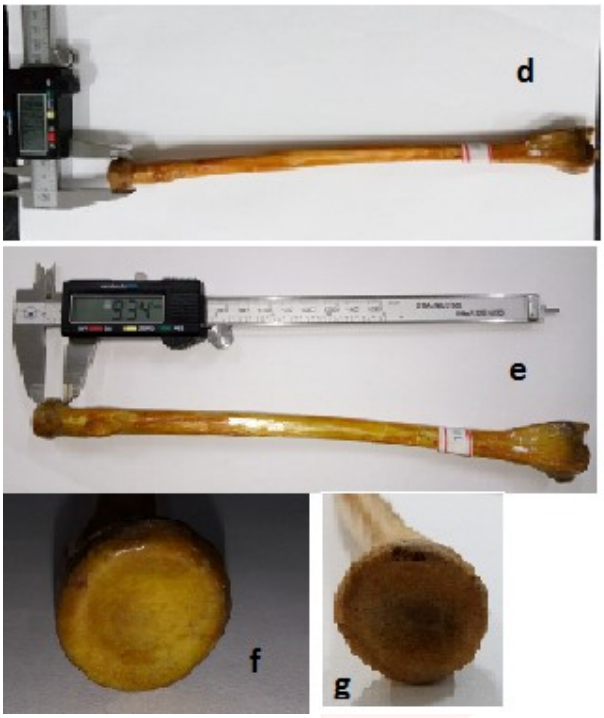
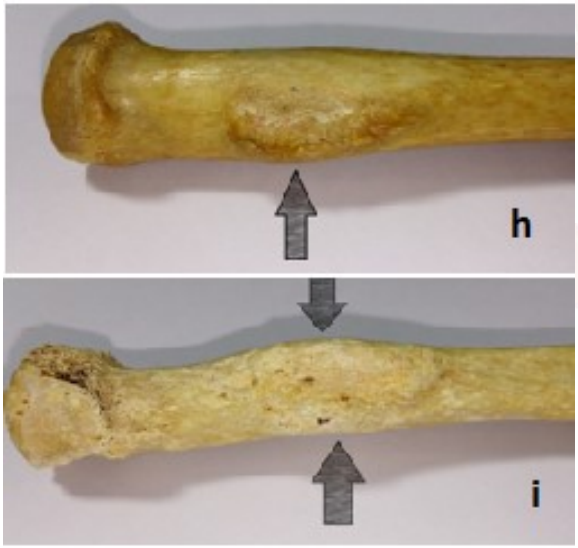



**Fig. 3: Bicipital Tuberosity,** h- single ridge, i- double ridge.




## RESULTS

The mean and range of all the measurements of the head of the radius, neck of radius and of bicipital tuberosity of right and left radii are shown in Table 1 to 3

The mean length of the radius was 24.35 ± 17.22 cm on right side and 23.62 ± 16.89 cm on left side.

The most common shape of radial head in our study was round or circular in 39 radii (65%) out of 60 radii and remaining showed oval shape.

In our study, we found single ridge on bicipital tuberosity most commonly in 53( 88.3%) out of 60 radii and remaining had bifid ridge .

**Table 1:** Measurements of head of the radius.

| Parameters | Mean ± Sd (cm) | Range ( cm) |
|---|---|---|
| Height of the head at medial end | | |
| Right | 0.86 ± 0.10 | 0.58 - 1.04 |
| Left | 0.95 ± 0.12 | 0.753 - 1.20 |
| Height of the head lateral end | | |
| Right | 0.71 ± 0.72 | 0.57 - 0.91 |
| Left | 0.73 ± 0.88 | 0.55- 0.94 |
| Height of the head at dorsal end | | |
| Right | 0.77 ± 0.88 | 0.56 - 0.90 |
| Left | 0.79 ± 0.86 | 0.62 - 0.94 |
| Height of the head at ventral end | | |
| Right | 0.85 ± 0.11 | 0.61 - 1.04 |
| Left | 0.87 ± 0.19 | 0.66 - 1.04 |
| Antero-posterior diameter of Head | | |
| Right | 2.03 ± 0.22 | 1.578-2.35 |
| Left | 1.99 ± 0.17 | 1.68-2.35 |
| Transverse diameter of Head | | |
| Right | 1.98 ± 0.24 | 1.54-2.39 |
| Left | 1.98 ± 0.18 | 1.52-2.38 |
| Depth of articular facet | | |
| Right | 2.87 ± 0.47 | 2.05 - 3.75 |
| Left | 2.93 ± 0.53 | 1.87 - 3.84 |

**Table 2:** Measurements of neck of Radius.

| Parameters | Mean +/- Sd ( cm) | Range ( cm) |
|---|---|---|
| Length of neck of radius | | |
| Right | 1.32 ± 0.22 | 0.82 - 1.67 |
| Left | 1.26 ± 0.27 | 0.75 - 1 91 |
| Proximal neck diameter | | |
| Right | 1.34 ± 0.16 | 1.06 - 1.57 |
| Left | 1.39 ± 0.17 | 1.12 - 1.83 |
| Distal neck diameter | | |
| Right | 1.32 ± 0.16 | 1.03 - 1.58 |
| Left | 1.33 ± 0.18 | 0.98 - 1.84 |

**Table 3:** Measurements of Bicipital tuberosity.

| Parameters | Mean +/- Sd ( cm) | Range ( cm) |
|---|---|---|
| Width of Bicipital tuberosity | | |
| Right | 1.24 ± 0.14 | 0.88 - 1.50 |
| Left | 1.19 ± 0.14 | 0.96 - 1.58 |
| Length of Bicipital tuberosity | | |
| Right | 2.23 ± 0.21 | 1.63 - 2.78 |
| Left | 2.33 ± 0. 29 | 1.64 - 2.77 |
| Circumference of radius at bicipital tuberosity | | |
| Right | 4.86 ± 0.48 | 3.65 - 5.74 |
| Left | 4.73 ± 0.53 | 3.76 - 6.22 |

There was no significant correlation in any parameter of radius on both right and left sides, as ' p ' value was more than 0.05.

## DISCUSSION

Captier et al., measured twenty seven parameters on proximal end of the radius on 96 radii. The circular shape of radial head was seen in 43% of radii and elliptical shape in 57%. They

concluded that biomechanics of the circular shape and the elliptical shape are different, involving an adaptation of the angle between the neck and the radial diaphysis. This difference must be considered for designing the radial head prosthesis [1].

Giannicola et al., analyzed 44 dry radius bones and measured the whole length of the radius, the length of the neck and head, and the minimum and maximum diameter of the radial head. The morphologic aspect of the neck–head curvature of the safe zone was evaluated qualitatively and quantitatively. The profile of the proximal radius in the safe zone shows substantial morphologic variations which will be useful while conducting surgery for fractures of the proximal radius, to avoid malunions, pain, and stiffness of the elbow joint [3].

The radial head plays a very crucial role in the stability of elbow and forearm, which has motivated many researchers to recommend preservation of radial head, either by operative fixation or by prosthetic replacement. Giannicola et al opined that osteosynthesis of radial head and neck fractures should be performed in safe zone, where a plate may be safely applied without jeopardizing the proximal radioulnar joint [3]. Mazzocca et al., measured radial length, length and width of the bicipital tuberosity , diameter of the radius just distal to the bicipital tuberosity, distance from the radial head to the bicipital tuberosity, radial head diameter, width of the radius at the bicipital tuberosity, radial neck-shaft angle. The morphology of the bicipital tuberosity ridge was defined as smooth small, medium, large or bifid. They concluded that none of the measurements correlated with patients age, sex, or race and the morphology of the bicipital tuberosity ridge is variable. The dimensions of the radius and bicipital tuberosity are applicable to several surgical procedures above the elbow [5].

Rajasree et al., conducted study on 100 dry radius bone of Indian origin. The mean length of radius on left side in 51 bones was 23.29 cm and on the right side is 23.73 cm in 49 bones. The shape of the head of the radius was found to be spherical or discoid in all the bones. The double ridge in bicipital tuberosity was found in 9 left bones and 16 right bones. The single ridge was seen in 13 left bones and 12 right bones. They concluded that dimensions of bicipital tuberosity and their angular relationship with radial head is important in pathophysiology and surgical treatment of biceps tendon rupture [6].

In a study conducted by Swieszkowski et al., on 17 radial head using a co-ordinate measuring machine integrated with computer aided design system. They measured maximum diameter , height of the radial head and depth of the radial head articular surface. They found no significant differences on the right and left sides [7].

Mall G et al., studied various parameters on humerus, ulna and radius to determine sex and estimation of stature in identification of unknown bodies or skeletal remains. The maximum radial length, radial head diameter and distal radial width was measured. A percentage of 94.9% were correctly classified in to male bones and female bones using radius bone [8].

**Table 4:** Comparison of the morphometric parameters of present study and other studies.

| Parameter | Chandni Gupta et al [4] | Rajasree et al [6] | Present study |
|---|---|---|---|
| Length of Radius( cm) | 23.5 | 23.5 | 23.9 |
| Head AP diameter (cm)f radius (cm) | 1.91 | 1.54 | 2.01 |
| Head transverse diameter(cm) | 1.85 | 1.34 | 1.98 |
| Depth of articular facet(cm) | 0.19 | --- | 0.29 |
| Neck Length (cm) | 1.19 | 1.35 | 1.28 |
| Width of bicipital tuberosity ( cm) | 1.23 | 1.65 | 1.21 |
| Length of bicipital tuberosity ( cm) | 1.97 | 1.16 | 2.29 |

Chandni Gupta et al.,found that radial head was round in 32 bones, oval in 18 bones and single ridge bicipital tuberosity in 30 bones and double ridge in 2 bones and smooth ridge in 18 bones [4] . While in a study by Rajasree et al found that the radial head was spherical or discoid in all the bones and no other specific shape was identified. They found single ridge bicipital tuberosity in 25 bones, double ridge in 25 bones and smooth surface in 25 bones [6].

In our study we found round shape of radial head in 39 bones and oval in 21 bones. single ridge bicipital tuberosity in 53 bones and double ridge in 7 bones.

## CONCLUSION

In our study, we analyzed the morphological and morphometrical parameters of proximal part of the radius. The most common shape of the head

of the radius was found to be round or circular. The bicipital tuberosity showed single ridge in 53 of 60 bones. Knowledge of size and shape of radial head is essential for manufacturing of radial head prosthesis that are anatomically and biomechanically suitable for Indian population. The dimensions of bicipital tuberosity and its angular relationship to radial head is important during surgical procedures like reconstruction of biceps tendon and reconstruction in proximal head fractures.

**Conflicts of Interests: None**

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