

**Original Article**

# MORPHOMETRY OF RADIAL HEAD: A GUIDE FOR RADIAL HEAD PROSTHESIS

Jasbir Kaur<sup>1</sup>, Firoz Khan<sup>1</sup>, Hitendra Kumar Loh<sup>1</sup>, Vandana Mehta<sup>1</sup>, Davinder Singh<sup>2</sup>

1. Department of Anatomy, VMMC & Safdarjung Hospital, New Delhi, India
2. Sports Injury Centre, VMMC & Safdarjung Hospital, New Delhi, India

## ABSTRACT

**Introduction:** Radial head fractures constitute one-third of all elbow fractures and 20% of all trauma cases. The head, being the key element is very important for maintaining stability and biomechanics of the humeroradial joint. Treatment of radial head fractures involves fixation or replacement with radial head prosthesis. However, the designing of prosthesis requires accurate knowledge of morphometry of proximal radius for a specific population to restore normal joint mechanics and joint morphometry. Henceforth, this study was carried out to determine dimensions of radial head in the North Indian subjects.

**Materials and methods:** The present observational study was conducted on one hundred dry adult human radii with an intact upper end. The parameters included Anteroposterior diameter of radial head (APD), Transverse diameter of radial head (TD), Medial height of radial head (MH), Lateral height of radial head (LH), Anterior height of radial head (AH), Posterior height of radial head (PH), Depth of superior articular facet (D), Surface area of head of radius (SA), Volume of head of radius (VOL), Ventral curve (VC), Dorsal curve (DC), Lateral curve (LC) and Circumference of the head (C). The side dimorphism was noted for any statistically significant side dimorphism.

**Results:** The morphometry of radial head revealed that the APD, TD were lesser by 2mm to 3mm as compared with western studies. The VC and the PC in the western studies were lesser by 0.4mm and 0.6mm respectively as compared to the current study.

**Conclusions:** These parameters are of importance for orthopaedic surgeons in the treatment of fractures of the upper radius, where a radial head implant or prosthesis is required. Accurately matched prosthesis in accordance with the size of head will reduce postoperative complications and result in better operative outcome.

**Keywords:** Radial head, Radial head prosthesis, Morphometry, Humororadial joint

**Address for Correspondence:**

Dr.Hitendra Kumar Loh, Director Professor, Department of Anatomy, VMMC & SJH, New Delhi, India  
Email: drhitendra3@gmail.com Mob: 9350809434

Date of Receiving: 21 Mar 2022  
Date of Acceptance: 13 Apr 2022  
ISSN: 0970-1842



## **INTRODUCTION**

Radius is the preaxial bone of the forearm, ossified from one primary centre and two secondary centres for upper and lower ends each. Proximal end of radius includes head, neck and radial tuberosity [1]. The radial head is cylindrical having an upper concave hollow surface that fits over the capitulum to form the humeroradial component of elbow joint. The cylindrical circumference is deepest on the medial aspect where it articulates with the radial notch of ulna to form superior radioulnar joint. The radial head is secured anteriorly, laterally and posteriorly within the annular ligament. The head and neck rotate freely within the clasp of the annular ligament during the rotational movements during supination and pronation [2].

Radial head fractures constitute 20% of all elbow trauma cases, 1.7 – 5.4% of all the fractures and one third of elbow fractures [3]. The surgical treatment of displaced radial head fractures where reconstruction is possible involves fixation with the help of plates and screws. However, the cases where the reconstruction is not possible, replacement of the radial head with prosthesis is the treatment of choice [4]. Any mismatch between the size of prosthesis and head of radius might result in subluxation of the head of radius [4]. Dislocation of radial head may further result in osteoarthritis, posterior interosseus nerve palsy and cubitus valgus

deformity [5]. Thus, in depth knowledge of morphometry of proximal radius is very important for orthopaedicians for a better postoperative outcome and for choosing anatomically and biomechanically accurate prosthesis in accordance with the size of radial head for different ethnic groups.

The radial head dimensions available to orthopaedic surgeons are frequently based on the studies conducted on western countries. This study is an attempt to construct a baseline of radial head morphometry in Indian subjects which may be utilized for making implants of radial head. The aim of this study is to evaluate the morphometry of radial head in North Indian subjects and compare the results with the previous studies.

## **MATERIALS AND METHODS**

The study on the morphometry of radial head is an observational study and was performed from March to June 2021. It was conducted on One-hundred dry adult human radial bones of unknown age and gender procured from the Bone bank of the department of Anatomy, Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi. Inclusion criteria included all the dry adult human radii with intact upper end. The anatomical dimensions were measured from these bones using a vernier calliper of 0.01mm accuracy. All the measurements were taken first by authors and rechecked by other two authors

to avoid human error. The observations were tabulated and statistical analysis was done.

The various parameters of radial head taken for the study are as follows:

1. Anteroposterior diameter of radial head (APD): The maximum anteroposterior distance was measured from most anterior point to most posterior point on the superior surface of radial head. [Fig. 1]
2. Transverse diameter of radial head (TD): The maximum transverse distance was measured from most medial point to most lateral point on the superior surface of radial head. [Fig. 2]
3. Medial height of radial head (MH): The maximum vertical distance measured from upper border of head to lower border of head on medial aspect. (Fig. 3)
4. Lateral height of radial head (LH): The maximum vertical distance measured from upper border of head to lower border of head on lateral aspect. (Fig. 4)
5. Anterior height of radial head (AH): The maximum vertical distance measured from upper border of head to lower border of head on anterior aspect. (Fig. 5)
6. Posterior height of radial head (PH): The maximum vertical distance measured from upper border of head to lower border of head on posterior aspect. (Fig. 6)
7. Depth of superior articular facet (D): The depth of superior articular facet was measured by making a plaster of paris cast of the shallow concavity of superior articular

facet. The maximum vertical height [h] of the cast formed was taken as depth of the superior articular facet. [6] (Fig. 7)

8. Surface area of head of radius (SA): Surface area of head of radius is calculated by using the formula:

$$SA = \pi [r^2 + h^2]$$

r = radius of articular surface of head excluding the circumferential rim.

h = Depth or height of superior articular facet [6] (Fig 7a,7b)

9. Volume of head of radius (V): Volume of head of radius is calculated by using the formula:

$$V = 1/6 \pi h [3r^2 + h^2]$$

r = radius of articular surface of head excluding the circumferential rim.

h = Depth or height of superior articular facet. [6] (Fig 7a,7b)

10. Thickness of ventral curve (TVC): It was measured as distance between point A and E on the peripheral rim on the surface of head of radius. [7] (Fig 8).

11. Thickness of dorsal curve (TDC): It was measured as distance between point C and G on the peripheral rim on the surface of head of radius [7] (Fig 8).

12. Thickness of lateral curve (TLC): It was measured as distance between point D and H on the peripheral rim on the superior surface of head of radius. [7] (Fig 8).

13. Circumference of head of radius: It was measured with the help of thread winding around articular peripheral rim of head of

radius. The length of the thread was measured along with the help of centimetre scale [7] (Fig. 8).

Data collection: The morphometric parameters of the radial head were taken using a digital vernier calliper of 0.01 mm accuracy. The above-mentioned parameters were taken into account.

Data analysis: The results were tabulated and mean; standard deviation of each parameter was analysed. The observations were compared on both right and left sides for any statistically significant side dimorphism.



**Fig 1: Anteroposterior diameter of radial head [APD]**



**Fig 2: Transverse Diameter of radial head [TD]**



**Fig 3: Medial Height of radial head [MH]**



**Fig 4: Lateral Height of radial head [LH]**



**Fig 5 : Anterior Height of radial head [AH]**



**Fig 6: Posterior Height of radial head [PH]**

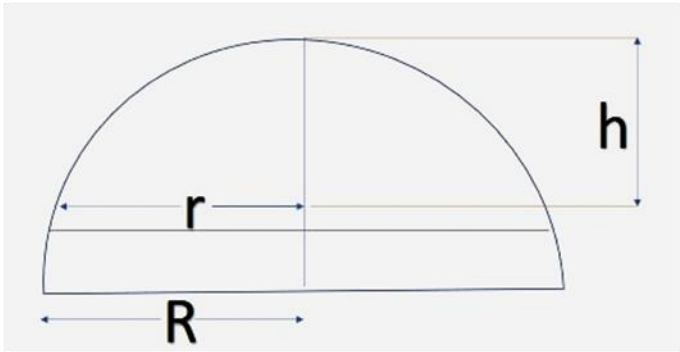


Fig 7 a: h= height or depth of articular surface,  
r= radius of articular surface of head and  
R= radius of hemisphere [6]

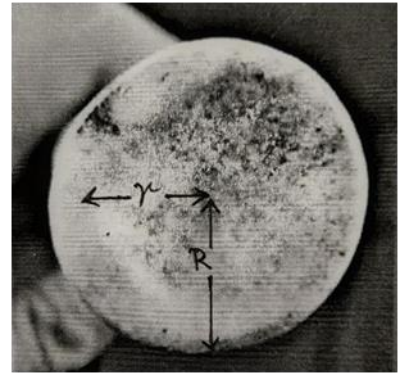


Fig 7b: r = radius of articular surface of head and  
R= radius of hemisphere

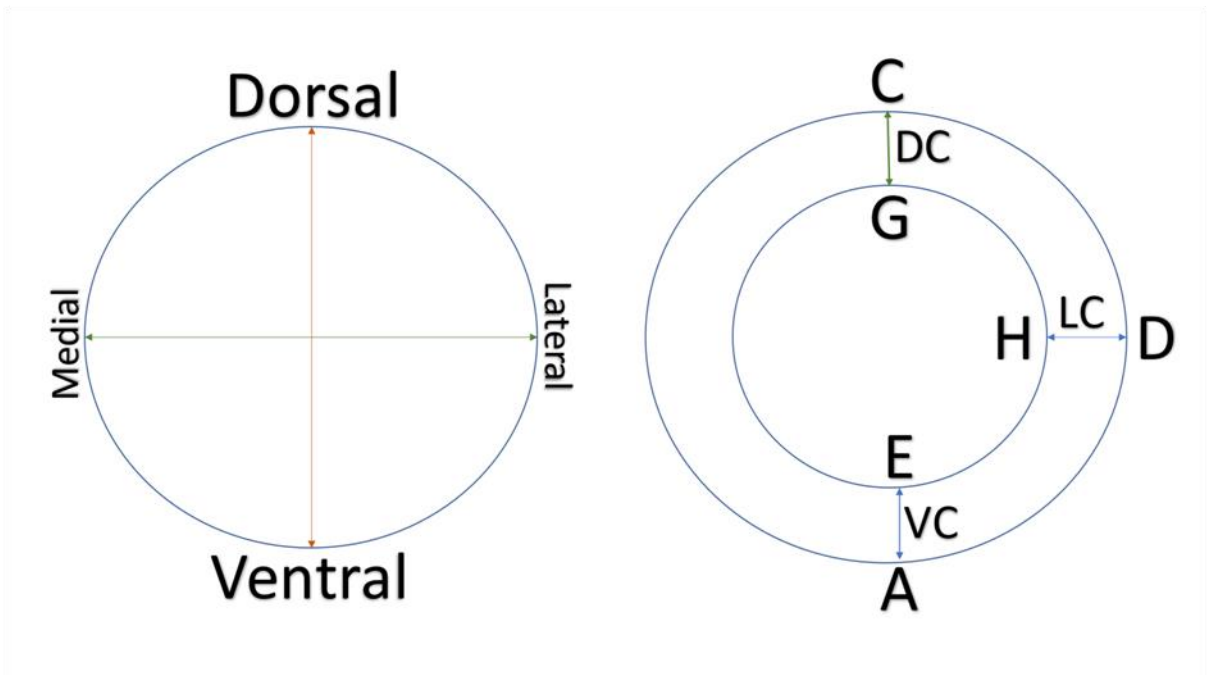


Fig 8: Superior surface of head of radius:  
VC: Ventral curve [A-E]  
DC: Dorsal curve[C-G]  
LC: Lateral curve[D-H]

## RESULTS

The mean and standard deviation of the various morphometric parameters including Anteroposterior diameter [APD], Transverse diameter [TD], Medial height [MH], Lateral height [LH], Anterior height [AH], Posterior height [PH], Depth[D], Surface area [SA], Volume [V], Thickness of ventral curve [TVC], Thickness of Dorsal curve [TDC], Thickness of Lateral curve [TLC] and Circumference of head [C], were recorded on right and left sides and the observations were tabulated.

Anteroposterior diameter of radial head was found to be  $19.6 \pm 1.89$  mm [R] and  $18.35 \pm 1.94$  mm [L]. Transverse diameter being  $18.88 \pm 2.17$  mm [R] and  $18.38 \pm 2.019$  mm [L]. Medial height was recorded to be  $9.86 \text{ mm} \pm 1.67$  mm [R] and  $9.55 \pm 1.92$  mm [L]. Lateral height was observed as  $7.91 \pm 1.14$  mm [R] and  $7.89 \pm 1.214$  mm [L]. Anterior height was  $8.5 \pm 1.67$  mm [R] and  $7.9 \pm 1.3$  mm [L]. Posterior height being  $8.38 \pm 1.5$  mm [R] and  $7.81 \pm 1.2$  mm [L]. Depth of the superior articular facet was  $2.34 \pm 0.6$  mm [R] and  $2.57 \pm 0.56$  mm [L].

Surface area was recorded to be  $193 \pm 57$  mm [R] and  $184.26 \pm 41.5$  mm [L]. Volume was recorded to be  $309 \pm 30$  mm [R] and  $275.3 \pm 117.6$  mm [L]. Thickness of ventral curve was recorded to be  $5.9 \pm 1.1$  mm [R] and  $4.92 \pm 1.6$  mm [L]. Thickness of dorsal curve was found to be  $4.9 \pm 0.93$  mm [R] and  $4.3 \pm 0.7$  mm [L].

Thickness of lateral curve was observed to be  $4.5 \pm 0.68$  mm [R] and  $4.38 \pm 0.76$  mm [L]. Circumference of the head was calculated as  $60.5 \pm 11.5$  mm [R] and  $57.6 \pm 10.7$  mm [L].

## DISCUSSION

The radius is the preaxial bone of the forearm which moves the hand, transmits weight from hand to the arm and participates in the movements of supination and pronation. Its proximal end contains disc shaped head, a constricted neck and an elevation called radial tuberosity. The radial head at the proximal end is an important pivot which causes its axial rotation within the annular ligament.

Further, it is the key element for maintaining physiologic [8] and prosthetic stability of elbow and superior radioulnar joints [9]. Due to the fact that the radial head plays an important part in maintaining the stability of elbow joint, it is crucial to preserve the radial head while performing operative procedures with the help of fixation or prosthetic replacement [10]. The prosthesis should be able to restore the anatomy as well as the physiologic functioning of the radial head as close to the normal as possible [6]. The latter can be obtained by replicating anatomical dimensions as close as possible to the original while designing the prosthesis [11].

Due to ethnic and racial variations of human bones the dimensions of the head

of the radius too display wide variations among different populations. Thus, the size of prosthetic implant also varies according to the different populations and these should be designed specifically in accordance with the concerned population. Thus, emphasizing the dire need for morphometry of proximal end of radius.

In the present study, One-hundred radial heads were revisited for various dimensions belonging to North Indian population. Anteroposterior diameter was recorded as  $19.6 \pm 1.89$  [R] and  $18.35 \pm 1.94$  [L]. In the previous studies it was recorded to be  $21.3 \pm 2.39$  on right side and  $21.2 \pm 2.2$  on left side [16],  $19.27 \pm 1.79$  on right side and  $18.74 \pm 2.71$  on left side [5],  $20.3 \pm 2.2$  and  $19.9 \pm 1.7$  on right and left sides respectively [12],  $19.6 \pm 1.8$  and  $18.7 \pm 2.1$  on right and left sides respectively [13],  $21.6 \pm 2.9$  [14].

Transverse diameter recorded was  $18.88 \pm 2.17$  on right side and  $18.38 \pm 2.019$  on left side in the present study. In previous studies it was recorded to be  $20.6 \pm 1.8$  on right side and  $20.6 \pm 1.9$  on left side [7],  $19.18 \pm 2.56$  and  $18.61 \pm 2.19$  on right and left sides respectively [5],  $9.8 \pm 2.49$  and  $19.8 \pm 1.8$  on right and left sides respectively [12],  $18.9 \pm 2.1$  on right side and  $18.2 \pm 2.1$  on left side respectively [13],  $21 \pm 2.7$  [14].

Medial height was observed to be  $9.86 \pm 1.67$

on right side and  $9.55 \pm 1.92$  on left side in the present study. However, it was found to be  $9.00 \pm 1.59$  on right side and  $8.77 \pm 1.439$  on left side [5],  $8.6 \pm 1.0$  and  $9.5 \pm 1.2$  on right and left sides respectively [12],  $9.1 \pm 1.0$  on right side and  $9 \pm 1.3$  on left side [13]. Lateral height was found to be  $7.19 \pm 1.14$  [R]  $7.89 \pm 1.214$  [L] in the present study. It was observed as  $6.53 \pm 1.65$  on right side and  $6.58 \pm 1.59$  on left side [5],  $7.1 \pm 7.2$  on right and  $7.3 \pm 8.8$  on left side [12],  $7.3 \pm 0.9$  on right side and  $7.7 \pm 1.4$  on left side [13].

Anterior height was found to be  $8.5 \pm 1.67$  [R]  $7.9 \pm 1.3$  [L] in the present study. It was found to be  $7.41 \pm 1.46$  on right side and  $7.61 \pm 1.69$  on left side [5],  $8.5 \pm 1.1$  and  $8.7 \pm 1.99$  on right and left side respectively [12]. Posterior height was observed to be  $8.38 \pm 1.5$  on right side and  $7.81 \pm 1.2$  on left side in the present study. When compared with the previous studies, posterior height was found to be  $7.63 \pm 1.52$  on right side and  $7.68 \pm 1.74$  on left side [5],  $7.7 \pm 8.8$  and  $7.9 \pm 8.69$  on right and left sides respectively [12].

The Depth of the superior articular surface was found to be  $2.34 \pm 0.6$  [R]  $2.57 \pm 0.56$  [L]. In the previous studies, it was found to be  $2.0$  on right and  $2.2$  on left side [15],  $2 \pm 0.6$  and  $1.9 + 0.51$  on right and left side respectively [13]. Surface area was observed to be  $193 \pm 57$  [R]  $184.26 \pm 41.5$  [L] in the present study. In the previous studies, it was found to be  $331.37 \pm 73.82$  [6].

Volume was observed to be  $309\pm30$  [R],  $275.3\pm117.6$ [L] in the present study. In the previous studies, it was found to be  $[322.49\pm122.74$  [6]. Thickness of Ventral Curve was found to be  $5.9\pm1.1$  R,  $4.92\pm 0.76$ L in the present study, In the previous studies it was found to be  $5.07\pm0.96$  [6],  $4.3\pm 0.5$  on right and  $4.1\pm0.8$  on left side [13] Thickness of Dorsal curve was observed to be  $4.9\pm0.93$  [R],  $4.3\pm0.7$  [L]. In the previous studies, It was found to be  $4.7$ . [14],  $4.02\pm0.94$  [6],  $3.2\pm0.6$  on right side and  $3.2 \pm0.75$  on left side [13]. Thickness of lateral curve was found to be  $4.5\pm0.68$  R,  $4.38\pm0.76$  L in the present study. In the previous studies it was found to be  $4.7$  [14],  $3.63\pm0.82$ , [6]  $3.3 \pm1$  on right and  $2.8\pm0.94$

on left side [13]. All the measurements are in millimetres [Table 2A, 2B]. Most of the previous studies did not observe the dimensions on the right and left side separately. They have recorded Anteroposterior diameter, Transverse diameter, Medial and Lateral height of the head of the radius, however, Anterior and Posterior height was recorded in fewer studies. The lateral curve, anterior curve, posterior curve was also reported in fewer studies. Surface area was recorded only in fewer studies including that conducted by Archana Singh and Arun Singh. To our knowledge there is no other study which has taken Medial curve morphometry into consideration.

S.No	Name of the parameter	Right [ Mean±SD] measured in mm	Left [Mean±SD] measured in mm
1.	Anteroposterior diameter [APD]	$19.6 \pm 1.89$	$18.35 \pm 1.94$
2.	Transverse diameter [TD]	$18.88 \pm 2.17$	$18.38 \pm 2.019$
3.	Medial height [MH]	$9.86 \pm 1.67$	$9.55 \pm 1.92$
4.	Lateral height [LH]	$7.19 \pm 1.14$	$7.89 \pm 1.214$
5.	Anterior height [AH]	$8.5 \pm 1.67$	$7.9 \pm 1.3$
6.	Posterior height [PH]	$8.38 \pm 1.5$	$7.81 \pm 1.2$
7.	Depth [D]	$2.34 \pm 0.6$	$2.57 \pm 0.56$
8.	Surface area [SA]	$193 \pm 57$	$184.26 \pm 41.5$
9.	Volume [V]	$309 \pm 30$	$275.3 \pm 117.6$
10.	Thickness of Ventral curve [TVC]	$5.9 \pm 1.1$	$4.92 \pm 1.6$
11.	Thickness of Dorsal curve [TDC]	$4.9 \pm 0.93$	$4.3 \pm 0.7$
12.	Thickness of Lateral curve [TLC]	$4.5 \pm 0.68$	$4.38 \pm 0.76$
13.	Circumference of the head	$60.5 \pm 11.5$ mm[R]	$57.6 \pm 10.7$ mm[L]

**Table-1: Mean and Standard deviation of morphometric parameters of radial head**



STUDY	Anteroposterior (APD)	Transverse Diameter (TD)	Medial height (MH)	Lateral Height (LH)	Anterior Height (AH)	Posterior Height (PH)	Depth
G. Captier [14]	21.6±2.9	21 ± 2.7	-	-	-	-	-
Anjana Mittal [7]	21.3 ±2.3 (R), 21.2±2.2 [L]	20.6+1.8 (R) 20.6+1.9 [L]	-	-	-	-	-
Riya Narwani [15]	-	1.81 – (R) 1.89- (L)	0.96 (R) 0.97 (L)	0.79 - (R) 0.82 - (L)	-	-	0.20- (R) 0.22 – (L)
Soorya Sridhar [5]	19.27 ± 1.79 (R) 18.74 ± 2.71 (L)	19.18 ±2.56 [R] 18.61 ± 2.19[L]	9.00 ±1.59 (R) 8.77 ±1.439 (L)	6.53 ±1.65 (R) 6.58±1.59 (L)	7.41 ± 1.46 (R) 7.61±1.69 (L)	7.63 ±1.52 (R) 7.68±1.74 (L)	-
Paul Puchwein et al 2013 [4]	19 ±1.58	-	-	-	-	-	-
Archana Singh and Arun singh [6]	20.50 ±2.33	19.53±2.26	8.65±1.55	6.28 ±1.09	-	-	1.96±0.44
Suraj Ethiraj, Jyothi kc, Shalaja Shetty [12]	20.3±2.2(R) 19.9±1.7(L)	19.8±2.49 (R) 19.8±1.8[L]	8.6± 1.0 (R) 9.5±1.2(L)	7.1±7.2[R] 7.3±8.8[L]	8.5±1.1 [R] 8.7± 1.99 (L)	7.7 ±8.8 (R) 7.9±8.69 (L)	-
Chandni Gupta et al [13]	19.6 ± 1.8 (R) 18.7± 2.1 (L)	18.9±2.1 (R) 18.2 ± 2.1[L]	9.1 ± 1.0 (R) 9.0± 1.3 (L)	7.3±0.9 [R] 7.7± 1.4[L]	-	-	2±0.6 [R] 1.9 +0.51(L)
Present study	19.6 ±1.89 (R) 18.35± 1.94 (L)	18.88 ±2.17 (R) 18.38 ±2.019 (L)	9.86±1.67 (R) 9.55±1.92 (L)	7.19±1.14 (R) 7.89±1.214 (L)	8.5±1.67 (R) 7.9±1.3 (L)	8.38±1.5 (R) 7.81±1.2 (L)	2.34±0.6 [R] 2.57±0.56 (L)

**Table 2A: Comparisons of morphometric dimensions with previous studies.  
\*All parameters measured in mm**

Study	Surface Area (SA)	Volume (VOL)	Ventral Curve (VC)	Posterior Curve (PC)	Medial Curve (MC)	Lateral Curve (LC)
G. Captier [14]	-	-	5.5	4.3	-	4.7
Anjana Mittal [7]	-	-	5.4	4.1	-	4./3
Archana Singh and Arun Singh[6]	331.37 ± 73.82	322.49±12 2.74	5.07 ±0.96	4.02 ±0.94	-	3.63±0.82
Chandni Gupta et al[13]	-	-	4.3± 0.5(R) 4.1 ±0.81(L)	3.2±0.6 (R) 3.2± 0.75 (L)	-	3.3±1.0 (R) 2.8±0.94[L]
Present study	193±57[R] 184.26 ±41.5 (L)	309±30[R] 275.3±117. 6 (L)	5.9±1.1[R] 4.92± 0.76(L)	4.9±0.93(R) 4.3±0.7(L)	5.1±0.89(R) 4.8±0.9(L)	4.5±0.68(R) 4.38±0.76(L)

**Table 2B: Comparisons of morphometric dimensions with previous studies**  
**\*All parameters measured in mm**

The results for the Anteroposterior diameter, Transverse diameter, Medial height, Lateral height recorded in the present study were similar to the previous studies done by Chandni Gupta et al[13], Suraj Ethiraj [12], and Surya Sridhar[5]. The results for anterior height were similar to Suraj Ethiraj et al [12] The results for Thickness of ventral curve were similar to Archana Singh and Arun Singh [6]. All these studies were conducted on Indian population. The results recorded in the western population showed higher values. The mean diameter of head was reported as 23±1.4 [14]. In another study, the mean values of Ventrodorsal and transverse diameters of the radial head were observed as 21.6±2.9 and 21.0±2.7 respectively [16]. It was observed that the radial head diameter

ranged between 22.8±1.9mm maximum and 21.8 ±1.9mm minimum by using computerized tomographic studies.

Broadly speaking our study corroborates to the dimensions of studies conducted on Indian population and differ from western studies thus emphasizing the racial variations in the morphometry of head and designing the prosthesis in accordance with the specific population. Further, the size of the prosthetic implant should accurately match the size of the head of radius as mismatch can result in various complications including valgus deformity and overstuffing of the radiocapitellar joint [4] and may not be able to restore the complex anatomy of proximal radius [16].

Also, these measurements also are of immense clinical significance. It has been observed that the height of the circumference of head is greatest on medial side  $9.86 \pm 1.67$  [R]  $9.55 \pm 1.92$  [L] in the present study as well as the previous studies [Table 2A]. The greater height of the medial sides responsible for the cam effect during rotation at proximal radioulnar joint. If the height on medial side is greater than normal, it will cause a reduction in the degree of supination and pronation. When this height is decreased there is a predisposition for upward displacement of head of radius.

As a result, the radioulnar ligaments and the interosseous membrane becomes lax increasing the instability of the joint [18,19]. The diameter of superior articular surface is very important deciding factor responsible for flexion at elbow joint. If the articular surface is large, flexion may be impaired. Head of radius if does not fit properly in radial fossa, there may be wearing of articular surface during movement and ultimately hampering the movement of elbow joint [20].

## CONCLUSION

The present study of morphometry of radial head in North Indian population in hundred dry adult human radii revealed that the APD, TD were lesser by 2mm to 3mm as compared with western studies. The VC and the PC in the western studies were lesser by 0.4mm

and 0.6mm respectively as compared to the current study.

## REFERENCES

1. Standring S, Ellis H, Healy JC, Johnson D. Gray's Anatomy – The anatomical basis of clinical practice. London, Elsevier Churchill Livingstone. 39th edition .2005; pp 842-852.
2. Last's Anatomy Regional and applied. R. M.H. McMinn ELBS.8th edition.1992; pp 34.
3. Caputo AE, Mazzocca AD, Santoro VM. The nonarticulating portion of the radial head: anatomic and clinical correlations for internal fixation. *J Hand Surg Am.* 1998; 23:1082-1090.
4. Puchwein P, Heidari N, Dorr K, Struger L, Pichler W. Computer aided analysis of radial head morphometry. *Orthopedics.* 2013; 36: e 51-7.
5. Sridhar S, Jajasree N, Srinivas H, Shankar DK, Chidambaram S. Morphometry of radial head and neck length in the population of Andhra Pradesh. *Int J of Anat Sci.* 2015; 6(1):10-15.
6. Singh A and Singh A. Morphometric study of head of radius and its clinical implication in radial head prosthesis. *Int J of AnatRadiolSurg,* February 2019; 8(1):20-23.
7. Mittal A, Ashwani U, Gurudev G, Sonia IK . Morphometric considerations of proximal radius- clinical implications in radial head

- implants. *Int J Sci res.* 2017 ;6(10) : 683-685.
8. Kapandji A. Biomechanics of pronation and supination of the forearm. *Hand clin.* 2001; 17:111-22.
9. Jensen SL, Olsen BS, Sjoberg JO. Elbow joint kinematics after excision of the radial head. *J Shoulder Elbow Surg.* 1999; 8: 238-41.
10. Van Eerten PV, Lindeboom R, Osterkamp AE, Goslings JC. An X-ray template assessment for distal radial fractures. *Arch Orthop Trauma Surg.* 2008; 128: 217-21.
11. Ahmed A, Sahay A. Morphometry of the superior articular surface of the head of radius *Journal of Anatomical sciences of India* 2016;65(2):104-13.
12. Ethiraj S, Jyoth KC, Shetty S. A study of morphology and morphometry of proximal end of dry radius bones with its clinical implications. *Int J Anat Res;* 2019 ;7: 6712-16.
13. Gupta C, Kalthur S, Malsawmzualli J, D' Souza A. A morphological study of proximal and distal ends of dry radii with its clinical implications. *Biomed J.* 2015;38 (4): 323-328.
14. Captier G, Canovas F, Mercier N, Thomas E, Bonnel F. Biometry of radial head: Biomechanical implications in pronation and supination. *SurgRadiol Anat .* 2007; 29 (3):279-284.
15. Narwani R Narwani A. A morphological and morphometric study of proximal end of dry radii in Rajasthan region and its clinical significance. *Int J Med Res Prof.* 2018; 4(6): 283-285.
16. Popvic N, Djekie J, Lemaire R, Gillet P. A comparative study between proximal radial morphology and the floating radial head prosthesis. *J Shoulder Elbow Surg.* 2005; 14: 433-440.
17. Itamura JM, Roidis NT, Chong AK, Vasishnav S, Papadakis SA, Zalavras C. Computed tomography study of radial head morphology. *J shoulder elbow surgery* 2008; 17(20):347-354.
18. Leppilathi J, Jalovaara P. Early excision of the radial head for fracture. *Int. Orthop* 2000;24: 160-62.
19. Mc. Gimlet JC, Kozin JH. Interosseus membrane anatomy and functional mechanics. *Clin Orthop.* 2001; 383: 108-22.
20. Ekeneokot UE, Osunwoke EA, Amasiatu VC and Ugwa OC. Morphometric study of the proximal end of the radius: its clinical implications. *European journal of biomedical and pharmaceutical sciences.* 2019; 6 (10): 323-332.