

ANTHROPOMETRIC ANATOMIZATION OF DISTAL RADIUS USING DIGITAL X-RAYS IN SOUTH INDIAN POPULATION

Orthopaedics

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ABSTRACT

Background: Population specific understanding of distal radius anthropometry is indeed an essential factor for managing fractures of distal radius which is most commonly encountered. The primary goal of treatment of distal radius fracture is to obtain an well functioning wrist joint with restored normal anatomy, for which reduction criteria based on western population is being used till now . Hence in this study we analyse the anthropometry of distal end of radius using digital xrays in south Indian population. **Materials and Methods:** Hundred patients with a normal wrist joint attending the Department of Orthopaedics and Traumatology unit of Government Medical College and ESI Hospital, Coimbatore were included in this study. Plain Radiographs were taken to measure the Radial Inclination, Palmer Tilt, Radial Height and Ulnar Variance and the values were compared with data reported in the literature. **Results:** The mean value of Radial Inclination($22.54^{\circ} \pm 2.18^{\circ}$), Palmer Tilt($12.01^{\circ} \pm 1.88^{\circ}$), Radial Height($11.30\text{mm} \pm 0.30\text{mm}$), and Ulnar Variance($0.44\text{mm} \pm 1.03\text{mm}$) in our study population differed on comparing with data reported in the literature for Western and other Indian population. **Conclusion:** This study concludes that significant differences exist between the values observed in our study population and the values reported in the literature for western population and other Indian population, which can be used as a reference criteria in managing the fracture distal radius among south Indian population.

KEYWORDS

Radial Inclination, Palmer Tilt, Radial Height, And Ulnar Variance

INTRODUCTION:

Significant population specific modifications are observed in the distal part of radius which needs to be need to be assessed for proper reduction of fracture of distal radius and proper implant designing for managing these fractures which helps us to restore the normal anatomy. Perhaps these geometric alterations are influenced by phenotypic diversification. Hence anthropometric analysis of distal radius offers great clinical and surgical values, specifically considering the potential phenotypic differences between the western and Indian population. Population specific morphological analysis help us to understand distal radius anatomy and its biomechanics, which becomes the basis for selecting optimal measures for correcting distal radius pathologies^[1,2]. Distal radius fractures are most commonly encountered among elderly people contributes to 15 to 18% of upper limb fractures, which more often needs to be reduced appropriately or operated using appropriate implants to attain good range of functional mobility.^[1,2] The restoration of radial inclination and the volar tilt is helpful in assessing the proper reduction of the distal end of radius fracture.^[1] The palmer tilt and reduction in radial height affects the grip strength and movements of wrist joint.^[3,4] Movements like pronation and supination which takes place in distal radio-ulnar joint and proximal radio-ulnar joint are related to the radial height and dorsal angulation.^[5] Kienbock's disease has inverse relation with ulnar variance^[7]. The axial force transmitted through the wrist by radiocarpal joint is around 80 % and remaining 20 % through ulnocarpal joint. Positive ulnar variance of 2.5mm transmits load of around 40 percent through ulnocarpal joint whereas negative ulnar variance decreases the load to one tenth through ulnocarpal joint^[1,6]. Hence commercially available implants which are developed based on western population morphometry fails to restore the anatomy when used among Indian population

MATERIALANDMETHODS:

This study was performed at the Department of Orthopaedics and Traumatology unit of Government Medical College and ESI Hospital, Coimbatore India from 2018 to 2019. Hundred distal radius were analysed in the age group 18-80 years and patients with normal wrist morphology were include in the study. Patients with wrist pathology, previous fractures, congenital deformities, were excluded. Plain radiograph of wrist joint in postero anterior and lateral view with neutral rotation were taken using 200mA Seimens Multiphos 15R X-Ray machine. Radial Inclination, Palmer Tilt, Radial Height, And Ulnar Variance were calculated using the "full-screen" view, and the images were magnified to maximize resolution and accuracy. Statistical analysis were done and T test was used for comparison of means of parameters and level of significance set for the P value is < 0.05. Datas were analysed between right and left side and male and female gender.

Radial Inclination:

For subtending the angle of radial inclination on PA view, first a line from the tip of the radial styloid of the radius to the medial edge of the distal radius (line A-B) then the second horizontal line is drawn (line B-C) perpendicular to the longitudinal axis of the radius (line D- E) at the level of the lunate fossa. Thus, the subtended angle ABC=a is the radial inclination angle.^[1] (Figure – 1)

Radial Height :

For measuring radial height in PA view, the first horizontal line (line A-B) drawn on the line perpendicular to the long axis of the radius (line C-D) passing through the distal tip of the radial styloid, and the second horizontal line drawn to perpendicular to the long axis of the radius passing through the lunate fossa (line E-F). Now, the length (h) between the two horizontal lines (line A- B to line E- F) is radial height.^[1] (Figure–2)

Palmer Tilt:

Palmer tilt was measured on lateral radiographs by drawing a line connecting the dorsal and palmer edge (line A- B) of the articular surface of the DER, then a perpendicular line (line B- C) from the palmer edge of the articular surface to the long axis (Line D-E) at the level of radial styloid process of the radius. Thus, the subtended angle (ABC=b) is the palmer tilt angle.^[1] (Figure–3)

Ulnar variance:

Ulnar variance was measured on PA radiographs. It is the distance (U) measured between the line A- B drawn at the cortical margin (perpendicular to the long axis, line E- F) of the distal ulna relative to the line C- D drawn at the cortical margin (perpendicular to the long axis, line G-H) of the distal radius. Measured values of ulnar variance were designated as positive or negative according to the relative distal or proximal position of the distal ulnar cortical margin (compared to the distal radial cortical margin), respectively.^[1] (Figure – 4)

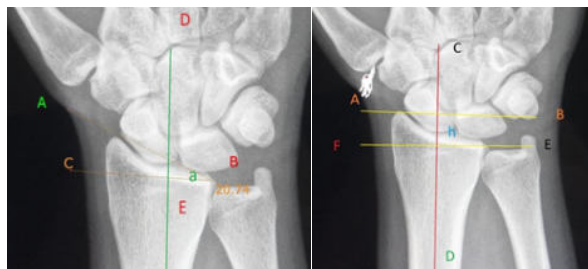


Figure -1

Figure -2

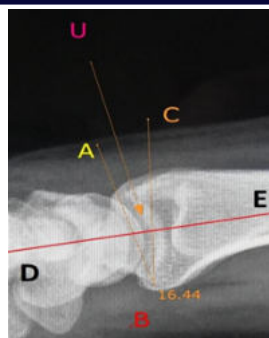


Figure -3

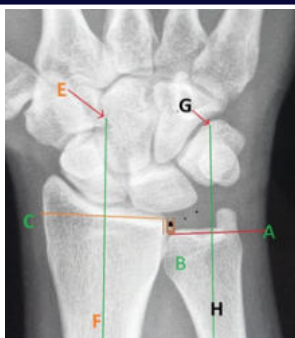


Figure -4

RESULTS:

the plain X rays of wrist joint of different participants of either right or left side were analysed in the study. There were 58 males and 42 females in the study. The right and left distribution was of 55 right (male - 30, female -25) and left was 45 (male -28, female- 17). The mean value of Radial Inclination was $22.54 \pm 2.18^\circ$, Palmer tilt was $12.01 \pm 1.88^\circ$, Radial Height was $11.30 \text{ mm} \pm 0.30 \text{ mm}$, And Ulnar Variance was $0.44 \text{ mm} \pm 1.03 \text{ mm}$. The outcomes of the study on various perspective are depicted in Table 1, 2 and 3

Table 1: Distribution of parameters

Parameter	Mean $\pm$ SD	Range
Radial Inclination($^\circ$)	22.54 ± 2.18	17.08 to 33.7
Palmer tilt($^\circ$)	12.01 ± 1.88	8.74 to 19.88
Radial Height(mm)	11.30 ± 0.30	8.09 to 17.56
Ulnar Variance(mm)	0.44 ± 1.03	- 3.01 to +3.94

Table 2: Distribution of parameters among Right and left side

Parameter	Right (Mean $\pm$ SD)	Left (Mean $\pm$ SD)	P value
Radial Inclination($^\circ$)	22.18 ± 2.01	21.11 ± 1.08	>0.05
Palmer tilt($^\circ$)	11.81 ± 1.09	10.12 ± 1.81	<0.05 (Significant)
Radial Height (mm)	11.01 ± 0.18	10.09 ± 0.88	>0.05
Ulnar Variance (mm)	0.42 ± 0.9	0.41 ± 0.7	>0.05

Table 3: Distribution of parameters among Right and left side

Parameter	Male (Mean $\pm$ SD)	Female (Mean $\pm$ SD)	P value
Radial Inclination ($^\circ$)	22.18 ± 2.01	21.11 ± 1.08	>0.05
Palmer tilt ($^\circ$)	11.81 ± 1.09	10.12 ± 1.81	>0.05
Radial Height (mm)	11.01 ± 0.18	10.09 ± 0.88	>0.05
Ulnar Variance (mm)	0.42 ± 0.9	0.41 ± 0.7	>0.05

DISCUSSION

The Indian subcontinent consists of varied populations with different genetic, morphological, and cultural characteristics, which are likely to impart variable bone anatomy. Knowledge of these anatomical differences are essential to understand the etiology of disease and achieve good surgical outcomes. The Indian population is also anatomically different from western population as our population is adapted to floor level activities and more manual labour. The earliest effect of malunion distal radius fractures, on the normal biomechanics of the wrist joint, was described by Gartland and Werley in 1951, who described a standard reference value to treat distal radius fracture which was based on western population morphometry, which is widely used around the globe^[1,2,7]. However they observed 31.7% of their cases had unsatisfactory outcome and also published that the loss of radial inclination had no significant variations in the final outcome^[1,2].

Johnson and Sazbo, a cadaveric study found that palmer tilt is influenced by the rotation.^[2,8] Hence, in a lateral view radiograph, the 5° of rotation is responsible for the 1.6° of alteration in the palmer tilt.^[2] A study by Pennock et al. has shown the effect of forearm rotation over the radial inclination, radial height, and palmar tilt^[2,9]. They found that supination increases the apparent measurements and forearm pronation decreases the apparent measurements significantly^[2,8,9]. Hence in our study we kept the forearm in neutral rotation to nullify the effect of pronation and supination.

In our study the mean Radial Inclination was $22.54 \pm 2.18^\circ$, which is lesser on comparing the study Chan et al (Malaysian)^[10] $27 \pm 3.18^\circ$ and Hadi et al (Indonesia)^[11] $23.99 \pm 3.75^\circ$ and more over similar on comparing with other Indian studies like Harshvardhan et al (South India)^[12]

$23.29 \pm 7.4^\circ$ and Mishra (North India)^[13] $23.27 \pm 7.42^\circ$. The less mean value of our study population can be attributed to the fact that our Indian population is smaller built when compared to western population. (Table - 4)

In our study the mean Palmer tilt was $12.01 \pm 1.88^\circ$, which is less when compared with the study Chan et al (Malaysian)^[10] $13 \pm 3.57^\circ$ and Hadi et al (Indonesia)^[11] $13.76 \pm 4.36^\circ$ and other Indian studies like Harshvardhan et al (South India)^[12] $10.09 \pm 5.23^\circ$ and Mishra (North India)^[13] $10.07 \pm 5.28^\circ$. (Table - 4)

In our study the mean Radial Height was $11.30 \pm 0.30 \text{ mm}$, which is equal when compared with the study by Hadi et al (Indonesia)^[11] $11.31 \pm 1.66 \text{ mm}$ and other Indian studies like Harshvardhan et al (South India)^[12] $11.33 \pm 4.7 \text{ mm}$ and Mishra (North India)^[13] $11.31 \pm 0.49 \text{ mm}$. (Table - 4)

In our study the mean Ulnar Variance (mm) was $0.44 \pm 1.03 \text{ mm}$, which depicts the fact that we Indian have a positive ulnar variance on comparing with the study Hadi et al (Indonesia)^[11] - 0.45

$\pm 2.03 \text{ mm}$ which stated a negative ulnar variance. Our study results correlates with other Indian studies like Mishra (North India)^[13] which also had positive ulnar variance. (Table - 4)

These variation in the morphometric factors depicts that the bone anthropology varies from region to region and a population specific anthropometric analysis is essential to restore the normal anatomy. Although there are some cadaveric studies about the anthropometry of distal radius, it is imperative to know in normal individuals to reciprocate it in patients.^[14,15]

Table :4 Comparison of various morphometric parameters of our study and other studies.

Parameter	Our Study Mean $\pm$ SD	Chan et al ^[10] (Malaysian)	Hadi et al ^[11] (Indonesia)	Gartland And Werley ^[7] (Philadelphia)	Harshvardhan et al ^[12] (South India)	Mishra ^[13] (North India)
Radial Inclination ($^\circ$)	22.54 ± 2.18	27 ± 3.18	23.99 ± 3.75	23 (13-30)	23.29 ± 7.4	23.27 ± 7.42
Palmer tilt($^\circ$)	12.01 ± 1.88	13 ± 3.57	13.76 ± 4.36	11 (1-21)	10.09 ± 5.23	10.07 ± 5.28
Radial Height (mm)	11.30 ± 0.30	-	11.31 ± 1.66	-	11.33 ± 4.7	11.31 ± 0.49
Ulnar Variance (mm)	0.44 ± 1.03	-	-0.45 ± 2.03	-	-	0.66 ± 2.46

CONCLUSION:

Anthropometric analysis of wrist joints using plain digital radiographs is a simple and cost effective method to establish bone biometrics in a local population. This study concludes that significant differences exist in distal radius and these biometric values vary significantly when compared with western population and other Indian populations.

Hence this study results can be taken up as reference values for treating the distal radius fracture in south Indian population. However, one of our study limitations is the collection of anthropometric data from only 100 people, which may not be representative of the general population. Hence a large multicentric study in south India is necessary to confirm and validate our results.

Financial support and sponsorship - Nil.

Conflicts of interest - There are no conflicts of interest.

REFERENCES

1. Morphometric study of distal end of the radius in the southern Assam population International Journal of Orthopaedics Sciences 2019; 5(2): 187-190

2. Mishra PK, Nagar M, Gaur SC, Gupta A. Morphometry of distal end radius in the Indian population: A radiological study. *Indian J Orthop* 2016;50:610-5.
3. Leung F, Ozkan M, Chow SP. Conservative treatment of intra-articular fractures of the distal radius-factors affecting functional outcome. *Hand Surgery*. 2000; 5(02):145-53.
4. Slutsky DJ. Predicting the outcome of distal radius fractures. *Hand Clinics*. 2005; 21(3):289-94.
5. Slutsky DJ. Predicting the outcome of distal radius fractures. *Hand Clinics*. 2005; 21(3):289-94.y. 1995; 29(4):349-55
6. Palmer AK, Werner FW. Biomechanics of the distal radioulnar joint. *Clin Orthop*. 1984; 187(7):8.
7. Gartland J. Evaluation of healed Colles' fractures. *J. Bone Joint Surg., A*. 1984; 33:747-9
8. Johnson PG, Szabo RM. Angle measurements of the distal radius: A cadaver study. *Skeletal Radiol* 1993;22:243-6.
9. PennockAT, PhillipsCS, Matzon JL, Daley E. The effects of forearm rotation on three wrist measurements: Radial inclination, radial height and palmar tilt. *Hand Surg* 2005;10:17-22.
10. Chan CY, Vivek AS, Leong WH, Rukmanikanthan S. Distal radius morphometry in the Malaysian population. *Malaysian Orthopaedic Journal*. 2008; 22(2):27-30.
11. Hadi SA, Wijiono W. Distal radius morphometry of Indonesian population. *Medical Journal of Indonesia*. 2013; 22(3):173-7
12. Vardhan H, Kumari R, Chouhan SK. Anatomy of distal end of radius: A radiological study done on adult population of Jharkhand state of India. *International Journal of Medical and Health Research*. 2017; 3:119
13. Mishra PK, Nagar M, Gaur SC, Gupta A. Morphometry of distal end radius in the Indian population: A radiological study. *Indian journal of orthopaedics*. 2016; 50(6):610.
14. Gupta C, Kalthur S, Malsavmzuali J, D'souza A. A morphological and morphometric study of proximal and distal ends of dry radii with its clinical implications. *Biomedical journal*. 2015; 38(4).
15. Prithishkumar IJ, Francis DV, Nithyanand M, Verghese VD, Samuel P. Morphometry of the distal radius—an osteometric study in the Indian population. *Indian J Basic Appl Med Res*. 2012; 1:166-71