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Morphometric study of distal end of the radius in the southern Assam population

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Abstract

Background: The morphometry of distal end radius (DER) comprises the four necessary parameters: radial inclination, palmer tilt, radial height, and ulnar variance. The unblemished intellect about the morphometry is urged for the management of fracture of DER. The goal of our study was to determine the values of morphometric parameters of the DER from the adult Indian

Materials and Methods: It was a single hospital- based observational cross- sectional, prospective study. Radial inclination, radial height, and ulnar variance were measured on posteroanterior view, and the measurement of palmer tilt was accomplished on the lateral view. All the statistical analysis was done by Microsoft XL 2007 (data add in function were installed for data analysis). One way annova was used for comparing the means of the parameters.

Results: Two hundred ($n = 200$) X- rays were included in this study to analyze. The mean value ($n = 200$) of radial inclination was $21.85^\circ \pm$ (standard deviation [SD]) 2.76° (range: $15-29.50^\circ$), palmer tilt $11.99^\circ \pm$ (SD) 2.88° (range: $7.44-18.50^\circ$), radial height $1.03 \text{ mm} \pm$ (SD) 0.21 mm (range: $0.64-1.63\text{mm}$), and ulnar variance $0.39 \pm$ (SD) 1.43 mm (range: $-3.0-+3.8$).

Conclusion: This study may provide an inaugurator plinth to prosecute the further analytical research in the Indian population. Moreover, the data may also be used as a reference data for the anatomical alignment while treating the injuries of the DER in the Indian population.

Keywords: DER, Radial inclination, Radial height, Palmer tilt, Ulnar variance

Introduction

Morphometry of the Distal end radius is significant in various conditions such as fracture of distal radius, distal radius plate design, and kinesiology. Distal radius fracture contributes around 15 to 18% of upper extremity fractures. It is common in old age group with osteoporosis and fall by outstretched hand. The restoration of the prefractured value of radial inclination and the volar tilt is helpful in assessing the proper reduction of the distal end of radius fracture [1]. The grip strength and kinematics of wrist joint is affected by any changes in the values of palmer tilt and also by any reduction in radial height [2, 3]. 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 [2, 4, 5]. Kienbock's disease has inverse relation with ulnar variance. The axial force transmitted through the wrist by radiocarpal joint is around 80 percent and remaining 20percent 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 [6, 7].

The morphometric measurement of the Distal end radius includes the necessary parameters as radial inclination, palmer tilt, radial height, and ulnar variance.

2. Materials and Methods

It was a single hospital based observational study. Wrist radiographs of either normal right or normal left side of the patients, attending Orthopaedics out Patient Department of Silchar Medical College Hospital from JULY 2017 to JUNE 2018. Who voluntarily gives consent were taken in the study. A standard protocol was followed for taking the radiographs. Only true posteroanterior and lateral view X-rays with neutral rotation was considered in the study. Radiographs not centered over the wrist and with the rotation were discarded.

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A total of 200 plain xays of different patients wrist joint were analysed in the study. All radiographs were corrected for magnification. For keeping the authenticity and to avoid the inter observer error, all the morphometric measurements were done by the single independent personnel. All the statistical analysis was done by Microsoft XL 2007 (data add in function were installed for data analysis). One way Anova test was used for comparing the means of the parameters and the level of significance set for the $P < 0.05$. Data were analyzed as a whole population and in the groups also (right side and left side group, male and female gender group). No comparison was made between right and left wrist for each patient.

We included the wrists only with the fused epiphysis. We excluded the entire wrist X-rays of the unossified bone and showing the irregularities due to structural deformity, injured DER, and pathological conditions (i.e., arthritis) because they could have been responsible for the mismeasurement. We also compared the right and left side's morphometric values of patients.

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 ($\angle ABC = \angle a$) is the angle of radial inclination.

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.

Ulnarvariance

Ulnar variance was measured on PA radiographs. It is the distance (h) 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.

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 ($\angle ABC = \angle b$) is the angle of palmer tilt



Fig 1: Palmer tilt was measured on lateral radiographs

3. Results

A total of 200 plain xays of wrist joint of different patients of either right or left side were analysed in the study. There were 135 (67.5%) males and 65 (32.5%) females in the study. The left and right distribution was of 94 (47%) left (35females, 59males) and 106 (53%) right (30females, 76males). The mean value of the radial height was 1.03cm with a standard deviation of 0.21cm (0.64-1.63). The mean radial inclination was 21.85° with 2.76° (15° - 29.50°). The palmar tilt averaged 11.99° with standard deviation of 2.88° (7.44° - 18.50°). The ulnar variance was 0.39 mm with standard deviation of 1.43 mm (-3.0 - $+3.80$). The positive ulnar variance was found to be more common in all the age groups and neutral ulnar variance is common next to positive ulnar variance in all the age groups. Negative ulnar variance was least common in all the age groups.

4. Discussion

The morphometric parameters vary from country to country, race, ethnic background and build of the patient. The earliest

effect of malunited distal radius fractures, on the normal biomechanics of the wrist joint, was described by Gartland and Werley in 1951. Their scoring system is used widely even till date to assess the functional outcome of treatment of distal radius fractures. Orthopaedic surgeons treating distal radius fractures classically use the available reference values of Gartland and Werley as a standard while treating these injuries.

They observed that 31.7% of their cases had unsatisfactory results because the dorsal tilt was not corrected and thus there exist strong correlation between palmar tilt and clinical outcomes. They also published that the loss of radial inclination had no appreciable effect on the final functional outcome of the patient.

In our study, the mean radial inclination was $21.85^\circ \pm 2.76^\circ$ range 15° - 29.50° . Prithishkumar *et al.* [10]. In their study observed the mean radial inclination to be in the range of $21.8 \pm 2.5^\circ$ to $22.1 \pm 2.9^\circ$. Chan *et al.* [9] in his study observed the mean radial inclination to be $25.1 \pm 3.42^\circ$. The Orthopaedic Trauma Association (OTA) criteria have a standard reference

value of the radial inclination to be 23° (Range 13° to 30°). The mean Radial Height observed in our study was 1.03 cm ±0.21 cm (0.64-1.63 cm) which was statistically significant at p < 0.05.

Hadi *et al.* [11] published that the mean radial height in the Indonesian population was 1.131 ± 0.166 cm. The OTA reference value is 1.1 to 1.3cm.

This could probably mean that orthopaedic surgeons tend to over distract the distal radius during procedures like ligamentotaxis and plating in order to meet the required acceptable radiographic criteria. Over distraction of the distal

radius could lead to the excessive strain of radio-carpal ligaments which in turn leads to the suboptimal functional outcome of these injuries in terms of hand grip and range of movements of the distal radius.

The various studies mention the negative mean value of ulnar variance, but our study depicted the positive ulnar variance, which is similar to the result (positive ulnar variance) of Malaysian study done over the Indian race, which emphasizes that Indian have positive ulnar variance. Study by Mishra *et al.* [8] showed that positive ulnar variance is more common in Indian population.

Table 1: Distribution of radial inclination, palmar tilt, radial height, and ulnar variance in n=200 subjects

Parameter	Mean±SD (range)	MALE (135)	FEMALE (65)	P Value
Radial inclination (°) (range)	21.85±2.76 (15-29.50)	21.90±2.73	21.32±2.32	>0.05
Palmar tilt (°) (range)	11.99±2.88 (7.44-18.50)	12.09±2.87	11.80±2.92	>0.05
Radial height (mm) (range)	1.03±0.21 (0.64-1.63)	1.06±0.22	0.99±0.19	<0.05 (0.032)
Ulnar variance (mm) (range)	0.39±1.43 (-3.0-+3.80)	0.46±1.47	0.24±1.35	>0.05

Table 2: Distribution of radial height, inclination and palmar tilt according to age group.

Sl. No	Parameters	≤ 30 yrs	31-60 yrs	≥ 60 yrs	P value
1	Radial height (cm)	1.04± .23	1.03± .20	1.03± .20	0.977
2	Radial inclination (0)	21.86±2.88	21.94±2.71	21.26±2.68	0.588
3	Palmar tilt (0)	12.03±3.18	11.95±2.72	12.05±2.97	0.918

Table 3: Comparison between Distal End Radius Morphometric Measurements in Our Study and the Reference Value Used By the Orthopaedic Trauma Association (Ota)

Parameters	Our Study	Ota Reference Value	MISHRA ⁸
Radial Inclination (0)	15-29.50	13-30	23.27±7.42(11.3-42.1)
Palmar Tilt (0)	7.44-18.50	1-21	10.07±5.28 (1-16.9)
Radial Height (Cm)	0.64-1.63	1.1-1.3	1.131±0.49 (0.71-3.04)
Ulnar Variancee(Mm)	-3.0-+3.80	NEUTRAL	0.66±2.46(-2.4-+4.1)

Table 4: Comparison between Radiological Morphometric Parameters of Our Study and Cadaveric Morphometric Parameters Other Similar Studies.

Parameters	Our Study	Gupta <i>et al.</i> 2015 (Indian Cadaveric Study) [16]	Prithishkumar <i>et al.</i> 2012 (Indian cadaveric study) [10]	Werner <i>et al.</i> , 1992 [14]	Schuind <i>et al.</i> [12],1992
Radial Inclination (0)	21.85±2.76 (15-29.50)	Total: 25.05 Left side: 24.0 Right side: 25.6	Left side: 21.8±2.5 Right side: 22.1±2.9	30	24 (19-29)
Palmer Tilt (0)	11.99±2.88 (7.44-18.50)	Not reported	Left side: 8.2±2.9 Right side: 9.1±2.0 (P=0.05)	6	Not reported
Radial Height (Mm)	10.3±2.1 (0.64-1.63)	Left side: 10±0.13 Right side: 9.7±0.14	Left side: 11±1.4 Right side: 10.8±1.5	Not reported	Not reported
Ulnar Variance (Mm)	0.39±1.43 (-3.0-+3.80)	Not reported	Not reported	-0.1-1.4	-4.2±2.3

Table 5: Comparison of Radiological Morphometric Parameters of Our Study and Similar Others Studies.

Parameters	Our Study	Chan <i>et al.</i> (Indian race) [9] 2008	Hadi <i>et al.</i> [11] (2013)	Altissimi <i>et al.</i> , [13] 1986	Gartland and Werley [15] 1951	Nekkanti <i>et al.</i> [17]	Harsh Vardhan <i>et al.</i> [18]
Radial Inclination (0)	21.85±2.76 (15-29.50)	27±3.18	23.99 ± 3.75°	16-28	23 (13-30)	21.58 ± 3.35	23.29±7.4
Palmer Tilt(0)	11.99±2.88 (7.44-18.50)	13±3.57	13.76 ± 4.36°	0-18	11 (1-21)	11.36 ± 3.16	10.09±5.23
Radial Height (Mm)	10.3±2.1 (0.64-1.63)	Not reported	11.31 ± 1.66 mm	Not reported	Not reported	0.88 ± 0.26	11.33±4.7
Ulnar Variance (Mm)	0.39±1.43 (-3.0-+3.80)	0.13±0.70	-0.45 ± 2.03 mm	-2.5-+3.1	Not reported	Neutral (56.7%) Negative (34.8%) Positive (8.4%)	

5. Conclusion

The knowledge of normal values of morphometry is important for any racial or population group. The fracture of distal radius accounts for 20% of all the fractures seen in accident and 8 to 15% of all the fractures seen in adults in upper limb.

From the above discussion it is evident that morphology of distal radius is important for the evaluation and treatment of the injuries around wrist especially distal end radius fracture.

Absolute knowledge of morphometric parameters of the distal radius is important for restoration of normal anatomical alignment which is essential for good functional outcome of the treatment.

This data may be used as a reference data for the normal anatomical alignment during treatment. This data may provide help to perform further studies in different parts of India. Further studies over a large population, with racial

consideration and comparing the radiographic and cadaveric morphometric parameters would be better to define the normal parameters of distal end radius in the Indian population.

It is suggested from this study to use morphometry data of the healthy side as individual reference value for the treatment of distal radius injury because there was no statistical difference between left and right side.

Limitations of the Study

The limitations of the study are that it was a single center study (single observer) with a small study group. Moreover, this study had the unequal distribution of gender and side which may affect the comparison of values. Hence, for the homogeneity, further observational studies involving multiple examiners and a larger number of patients are needed.

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