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"Morphometry of the distal radius – an osteometric study in the Indian population."

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Abstract:

Introduction: Morphometric parameters of distal radius such as palmar tilt and angle of radial inclination play a significant role in the reduction of distal radius fractures, kinematics of wrist, and design of distal radius prosthesis.

Aim: The aim of the study was to determine the morphometric parameters of distal radius in dry adult Indian bones.

Materials and methods: One hundred and thirty two (132) intact adult Indian radius (Right=69; Left = 63) were chosen, and the following parameters measured: length of radius, palmar tilt, angle of radial inclination, length of radial styloid process, and widths of distal radius. Student t – test and Spearman's rank correlation was done.

Results: The mean radial inclination was 21.8º ± 2.5 on the left side; and 22.1º ± 2.9 on the right (p = 0.57). The mean palmar tilt was 8.2º ± 2.9 on the left; and 9.1º ± 2.0 on the right (p = 0.05). **Discussion:** The length of radius correlates negatively with palmar tilt, and positively with width of distal radius; length of radial styloid correlates positively with angle of radial inclination. Angles of radial inclination and palmar tilt are much less in the present study compared to earlier studies.

Conclusion: More studies comparing radiographic and morphometric measurements may need to be done to better define normal parameters of distal radius in a population group.

KEYWORDS: distal radius; palmar tilt; radial inclination

Introduction :

The morphometry of the distal radius is important in various clinical orthopedic settings such as reduction of distal radius fractures, design of distal radius prosthesis, and kinematics of the wrist joint. Four important morphometric parameters include palmar tilt, angle of radial inclination, ulnar variance and length of radial styloid. The correlations between these parameters and functional outcome following fracture reduction, and biomechanics of the wrist joint have been well established.[1,2] Radial shortening, increased radial inclination and dorsal angulation cause significant alterations in the kinematics of the wrist joint and grip strength. Even pronation and supination are related to the initial length of radius and dorsal angulation. [3-5]

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Most previous studies have determined the morphometry of distal radius using anterior-posterior and lateral wrist radiographs. This method of radiological assessment using plain X-rays has been strongly criticized by some authors and considered unreliable with limited reproducibility; the greatest difficulty being the determination of the radial axis in the anterior–posterior view. [6-11] Several recent studies have shown that even minor rotational variations in wrist positioning during radiography affect these measurements and could adversely affect treatment decisions. [7-9,11] Racial differences are known to exist in morphometry of the distal radius. [1]

The aim of this study was to determine the morphometric parameters of the distal radius from dry adult Indian bones. To the best of our knowledge, there are no direct osteometric studies reported on the morphometry of distal radius done in the Indian population with relevance to clinical orthopedics.

Materials and methods :

A total of 132 intact, normal, completely ossified, adult Indian radius bones belonging to the department of anatomy, Christian Medical College, Vellore were included in the study (Right = 69; Left = 63). Bones with incomplete ossification, previous fracture or deformity were excluded from the study. The parameters measured were: length of radius, palmar tilt, angle of radial inclination, length of radial styloid process, and width of distal radius at 'a', 'b' and 'c' (Figures 1,2,3).

Palmar tilt represents the angle between, a line joining the centre of dorsal and volar margins of the articular surface of distal radius, and the perpendicular to the long axis of the radius (fig.1).

The angle of radial inclination is the angle between, a line joining the tip of radial styloid and the medial edge of the distal end of radius, and a line perpendicular to the long axis of the radius (fig.2). Width 'a' is the maximum width of the distal radius along a perpendicular to the long axis of the radius, at the level of the medial edge of radius (fig.3). Width 'b' is the oblique width of the radius along its distal margin (fig.3). Width 'c' is the maximum anterior-posterior width of the distal radius. Length of radial styloid is the distance between the tip of radial styloid, and a perpendicular to the long axis of the radius at the level of the medial edge distal radius (fig.3).

The length of radius was measured using an osteometric board; angle of inclination and palmar tilt were measured using a long armed goniometer as shown in the figures; all other parameters were measured using sliding vernier calipers. Student t – test was used to compare measurements of the left and right radius. Spearman's rank correlation was used to assess the relationship between the various measurements. The data was analyzed utilizing SPSS version 11.0, Chicago.

Results:

The results are tabulated in tables 1-3. The mean radial inclination was 21.8 º ± 2.5 on the left side; and 22.1 º ± 2.9 on the right (p = 0.54). The mean palmar tilt was 8.2 º ± 2.9 on the left; and 9.1 º ± 2.0 on the right (p = 0.05). Palmar tilt was more on the right radius as compared to the left (p = 0.05); however its clinical significance must be correlated. There was no statistically significant difference in length of radius, angle of radial inclination, length of radial styloid or the width of distal radius between the two sides.

Table 2 shows the correlation analysis of the left radius. On the left side, the length of radius had a negative correlation with palmar tilt ($p = 0.04$). As length of radius increased, the palmar tilt decreases. Length of radius had a positive correlation with length of radial styloid ($p = 0.007$); length of radius correlates highly significantly with the widths a, b and c ($p = 0.0001$); length of radial styloid correlates positively with the angle of radial inclination ($p = 0.004$); length of radial styloid also correlates positively with the widths a, b and c ($p \leq 0.001$).

Table 3 shows the correlation analysis of the right radius. On the right side, the length of radius had a negative correlation with palmar tilt ($p=0.01$); length of radius correlates significantly with the widths a, b and c ($p = 0.0001$); length of radial styloid correlates positively with the angle of radial inclination ($p = 0.0001$).

Discussion:

Distal radius fractures account for up to fifteen percent of all upper limb fractures; the goal of treatment being restoration of the normal anatomical alignment. [3] The quality of reduction is assessed mainly by degree of restoration of radial angle of inclination and palmar tilt. [10] However, the criteria currently used to evaluate the quality of reduction are based on western figures. [1]

This method of assessment using plain radiographs has been criticized by some authors. [6-11] Johnson and Szabo (1993) did a cadaver based study to investigate the effects of forearm rotation on these radiologic parameters. [12] They found that a 5 ° rotation produced a 1.6° change in palmar tilt on a conventional lateral view. A rotation of 20 ° produces a 6.4° change in measured palmar tilt. They state that lateral radiographs could even be rotated up to 15°–30° and still be considered acceptable. Pennock et al. (2005) studied the effects of forearm rotation on radial inclination, radial height and palmar tilt. [9] They found that all three measurements were significantly affected by forearm rotation with forearm supination increasing the apparent measurements and forearm pronation decreasing the apparent measurements. Slight alterations of the wrist during imaging may significantly alter management decisions. [11]

Table 4 compares the present study with other racial groups. Though the angle of inclination is comparable, the angle of palmar tilt is significantly less in the present Indian study. Table 5 compares the present study with previous studies, most of which were X-ray based.[1,13-16] The study done by Werner et al., (1992) showed the highest angle of inclination and the lowest palmar tilt.[16]

Conclusion:

Knowledge of normal values of morphometry is important for any racial or population group. Angles of radial inclination and palmar tilt are much less in the present Indian study as compared to earlier studies. Palmar tilt is less on the left as compared to the right. More studies comparing radiographic and morphometric measurements may need to be done to better define normal parameters of distal radius in a race or population.

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Fig. 1 – measurement of angle of palmar tilt

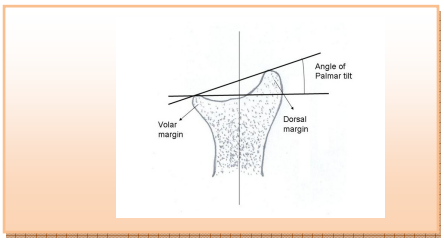

Fig. 2 – measurement of angle of radial inclination

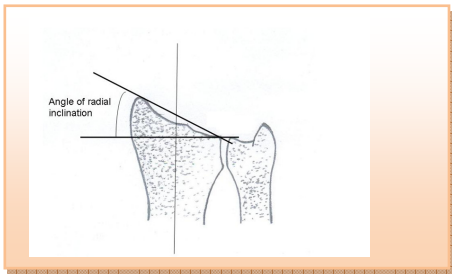

Fig. 3 – measurement of width of distal radius

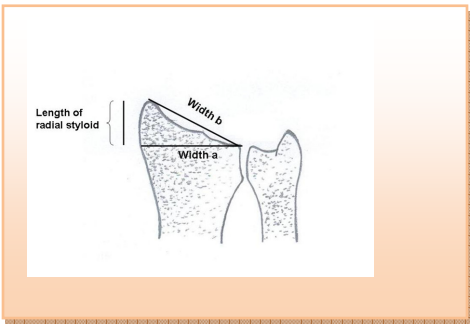

Table 1 – Morphometric parameters of distal radius in Indian dry bones

Measured parameters	**Left**			**Right**			**P- value**
	Range	Mean	SD	Range	Mean	SD	
Length of Radius (mm)	208 – 277	244	16.5	194 -270	242.9	17.4	**0.71**
Radial inclination (º)	13 – 29	21.8	2.5	12 -33	22.1	2.9	**0.54**
Palmar tilt (º)	-2 – 19	8.2	2.9	1 - 19	9.1	2.0	**0.05**
Length of rad styloid (mm)	7 – 15	11.0	1.4	7 - 18	10.8	1.5	**0.44**
Width a (mm)	21 – 32	26.7	2.2	20 - 32	26.3	2.4	**0.33**
Width b (mm)	22 – 33	27.2	2.2	19 - 33	26.7	2.3	**0.22**
Width c (mm)	**14 – 23**	**17.8**	**1.6**	**12 - 28**	**17.5**	**1.7**	**0.31**

Table 2 – Pair wise correlation analysis of left radius

		Len Ra	Rad inc	Pal tilt	Rad sty	Wid a	Wid b	Wid c
Len Ra	Correlation coefficient	1						
	P – value							
Rad incl	Correlation coefficient	0.12	1					
	P – value	0.33						
Pal tilt	Correlation coefficient	-0.25	-0.009	1				
	P – value	0.04	0.93					
Rad sty	Correlation coefficient	0.33	0.35	0.02	1			
	P – value	0.007	0.004	0.84				
Wid a	Correlation coefficient	0.61	0.01	-0.19	0.32	1		
	P – value	0	0.93	0.13	0.01			
Wid b	Correlation coefficient	0.54	0.03	-0.09	0.37	0.93	1	
	P – value	0	0.76	0.47	0.002	0		
Wid c	Correlation coefficient	0.56	0.003	-0.07	0.39	0.78	0.74	1
	P – value	0	0.97	0.53	0.001	0	0	

(Len Ra – length of radius, Rad inc – angle of radial inclination, Pal tilt – Palmar tilt, Rad sty – length of radial styloid, Wid a – width at a, Wid b – width at b, Wid c – width at c)

Table 3 – Pair wise correlation analysis of right radius

		Len Ra	Rad inc	Pal tilt	Rad sty	Wid a	Wid b	Wid c
Len Ra	Correlation coefficient	1						
	P – value							
Rad incl	Correlation coefficient	-0.05	1					
	P – value	0.66						
Pal tilt	Correlation coefficient	-0.29	-0.008	1				
	P – value	0.01	0.94					
Rad sty	Correlation coefficient	0.13	0.61	-0.12	1			
	P – value	0.27	0	0.32				
Wid a	Correlation coefficient	0.65	-0.09	-0.16	0.11	1		
	P – value	0	0.43	0.19	0.38			
Wid b	Correlation coefficient	0.59	-0.04	-0.15	0.15	0.94	1	
	P – value	0	0.73	0.23	0.21	0		
Wid c	Correlation coefficient	0.54	0.17	-0.11	0.25	0.70	0.65	1
	P – value	0	0.16	0.36	0.04	0	0	

(Len Ra – length of radius, Rad inc – angle of radial inclination, Pal tilt – Palmar tilt, Rad sty – length of radial styloid, Wid a – width at a, Wid b – width at b, Wid c – width at c)

Table 4: Comparison of radial inclination and palmar tilt between racial groups (Chan et al., 2008[1])

	Malay (Chan et al.,2008[1])	**Chinese (Chan et al.,2008[1])**	**Previous Indian study (Chan et al.,2008[1])**	**Present study**
Radial inclination	24.8 ± 3.03	24.1 ± 3.77	27.0 ± 3.18	**L = 21.8 ± 2.5 R = 22.1 ± 2.9**
Palmar tilt	**12.9 ± 3.78**	**11.8 ± 2.77**	**13.0 ± 3.57**	**L = 8.2 ±2.9 R = 9.1 ± 2.0**

Table 5: Comparison of radial inclination and palmar tilt of different studies done on distal radius

	Gartland and Werley, 1951[13]	**Altissimi et al, 1986[14]**	**Schuind et al, 1992[15]**	**Werner et al, 1992[16]**	**Chan et al, 2008[1]**	**Present study**
Radial inclination	23° (13-30)	16-28 °	24° (19-29)	30°	25.1°± 3.42	**L = 21.8 ± 2.5 R = 22.1 ± 2.9**
Palmar tilt	**11° (1-21°)**	**0 – 18 °**	**Not reported**	**6°**	**12.6 ° ± 3.55**	**L = 8.2 ±2.9 R = 9.1 ± 2.0**

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