

## Original research article

## Assessment of the age and sex variation in the distal radius morphology: an observational study

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### Abstract

**Aim:** To assess age and sex variation in the distal radius morphology in normal Indian population presents to secondary care centre.

**Material and method:** A cross-sectional prospective study was conducted in the Department of Orthopedics, SDH, Bagaha, West Champaran, Bihar, India, Total 160 healthy individuals were included in this study. We investigated the radiological distal radius index changes between four age groups. The study population included 160 normal subjects who were equally divided into four age groups (below 10 years, 10-20 years, 20-50 years, and above 50) of 20 males and 20 females according to age and sex. Radial inclination (RI), radial length (RL), palmar tilt (PT), and ulnar variance (UV) were measured in millimeters by the investigators. The measurements were performed with an orthopedic goniometer and a ruler.

**Results:** The average RI, PT, and RL was 24.11°, 11.88°, and 11.22 mm, respectively. Also, the average UV was +1.22 in the two above 20-year-old age groups. There was not any significant difference between the age groups except for UV. The UV in the two groups below-20-years-old was significantly different from the two groups above-20-years-old. But, no significant difference was observed between the two groups below-20, as well as between the groups above 20 regarding UV variation. No significant difference was detected between the males and females in any of the age groups regarding the mean variables. Although the mean UV in males and females belonging to the group 10-20-year-olds was -2.41 and -0.79, respectively, and the difference was not statistically significant.

**Conclusion:** There is significant ulnar variance change toward less negative ulnar variance with aging until maturity.

**Keywords:** Age, Palmar tilt, Radial inclination, Radial length, Ulnar variance

### Introduction

The radius is one of the long bones, and its distal part is broader than its proximal part. The shaft widens rapidly toward its distal end, and its distal part is anteriorly concave.<sup>1</sup> There have been several morphological studies of the radius in the fields of forensic anthropology and orthopedics. In forensic anthropology, several researchers have studied the radius to identify features useful for sex determination, specifically using the whole length and head diameter of the radius or the surface area and volume from three-dimensional (3D) radius models.<sup>2-6</sup> In orthopedic research, the shape of the distal radius has been studied for understanding of distal wrist fractures and plate design.<sup>7-10</sup> Recently, the frequency of wrist fractures has been rising. One reason is that there is an increasing number of elderly who fall, which is accompanied by a rise in the elderly population due to prolonged life expectancy. Another reason is that there are an increasing number of people who slip on icy streets in snowy weather, which is influenced by abnormal climate changes. Lastly, postmenopausal women have a higher risk of wrist fracture due to bone density loss. According to the

National Health Insurance Sharing Service of Korea, the frequency of wrist and hand fractures increased by 2.5% from 2013 to 2014, while treatment costs increased by 29.6%. Therefore, it is necessary to review surgical methods for the distal part of the radius and describe the shape of the anterior surface to design proper plates and reduce complications after surgery. Some researchers have been studying the shape of the distal radius for developing and evaluating suitable plates for wrist surgery<sup>7-10</sup>; while some of these studies have shown the concave shape of the anterior surface of the distal radius at an angle with regard to the shape of plate, there is still lack of morphological information about the anterior surface of the distal radius.

### **Material and methods**

A cross-sectional prospective study was conducted in the Sub Divisional Hospital, Bagaha, West Champaran, Bihar, India.

### **Methodology**

Total 160 healthy individuals were included in this study. We investigated the radiological distal radius index changes between four age groups. The study population included 160 normal subjects who were equally divided into four age groups (below 10 years, 10-20 years, 20-50 years, and above 50) of 20 males and 20 females according to age and sex. The study population was carefully selected to include equal representation of the sexes. Subjects with a history of previous wrist surgery, fractures, and congenital wrist deformities were excluded. Informed consent was obtained from all of the study subjects. The low complications of undergoing wrist radiography were explained to all subjects. Also, lead protective equipment for the sensitive body areas was accessible for the subjects in the radiology ward of the emergency department. The standard anteroposterior radiography view was taken with 90° shoulder abduction, 90° elbow flexion, neutral forearm regarding rotation, neutral wrist regarding ulnar or radial deviation and palmar flexion, palm on the radiographic film, and the radiation source was at 100 cm distance.<sup>11</sup> In addition, the standard lateral view was taken with 0° shoulder abduction, 90° elbow flexion, wrist in the neutral position and on the radiographic film, and the radiation source was at 100 cm distance.<sup>11</sup> We double checked the radiographic qualities. The main criterion of the true anteroposterior view of the wrist is that the groove of extensor carpi ulnaris to the styloid process of ulna should be seen. Yet, the main criterion of the true lateral view of the wrist is that the anterior surface of the pisiform bone should be between the anterior surfaces of the distal tuberosity of the scaphoid and capitate head. Also, straightness of the posterior surfaces of the metacarpals, radius, and ulna is the subsidiary criterion of the lateral view of the wrist.<sup>12</sup> Radial inclination (RI), radial length (RL), palmar tilt (PT), and ulnar variance (UV) were measured in millimeters by the investigators. The measurements were performed with an orthopedic goniometer and a ruler.

### **Statistical Analysis**

All the statistical analyses were performed using SPSS 20 software (SPSS Inc., Chicago, IL, USA). In this study, multiple comparison tests including student t test and one-way ANOVA post hoc test were used in order to determine the differences between the study groups. The t test was performed to analyze radiological index differences between the males and females. The post hoc test (least difference test) was performed to analyze radiological indexes between pairs of groups. P values less than 0.05 were considered statistically significant.

### **Results**

The average RI, PT, and RL was 24.11°, 11.88°, and 11.22 mm, respectively. Also, the average UV was +1.22 in the two above 20-year-old age groups. There was not any

significant difference between the age groups except for UV. The UV in the two groups below-20-years-old was significantly different from the two groups above-20-years-old. But, no significant difference was observed between the two groups below-20, as well as between the groups above 20 regarding UV variation [Table 1]. No significant difference was detected between the males and females in any of the age groups regarding the mean variables. Although the mean UV in males and females belonging to the group 10-20-year-olds was -2.41 and -0.79, respectively, and the difference was not statistically significant [Table 2].

**Table 1: The mean of RI, PT, RL, and UV**

Age in years	RI	PT	RL	UV
Below 10 years	-----	-----	-----	-2.52
10-20	-----	-----	-----	-1.7
20-30	24.1	13.2	11.1	0.85
30-40	24.5	12.9	10.8	1.21
40-50	23.9	12.3	9.7	1.41
Above 50	24.12	12.1	10.6	1.12
<i>P</i> .value	0.879	0.759	0.698	0.000

**Table 2: The mean of RI, PT, RL, and UV in men and women**

Parameter	Men	Women	<i>P</i> .value
RI	23.7	22.74	0.575
PT	12.2	12.95	0.696
RL	11.7	10.87	0.176
UV	-0.4	-0.6	0.545

RI: Radial inclination RL: Radial length , PT: Palmar tilt, UV: Ulnar variance

**Table 3: The comparison of the indexes of distal radius between Medoff's, Friberg's and the present study**

	RI	PT	RL	UV
Medoff's study	23.77±2.63 ( <i>P</i> .value:0.698)	11.33±4.78 ( <i>P</i> .value:0.141)	11.58±1.57 ( <i>P</i> .value:0.024)	- 0.7±0.8 ( <i>P</i> .value:<0.001)
Present study	24.11±3.16	11.88±3.79	11.22±2.71	1.22±1.44
Friberg's study	24± 2.6 ( <i>P</i> .value:0.013)	9.4± 2.6 ( <i>P</i> .value:0.001)	12.1± 2.5 ( <i>P</i> .value:0.001)	-0.12±1.62 ( <i>P</i> .value:0.000)

## Discussion

We aimed to evaluate any anthropometric changes related to aging. Understanding changes can be used in forensic medicine and in the evaluation of surgical procedures and designing of implants according to age and sex. Comparison of distal radiological indexes using MedCale software (v. 12) showed no significant differences between the present study and the one performed by Med off regarding RI and PT.<sup>13</sup> However, a significant difference was found between the two studies regarding RL and UV. Of course, the comparisons were made only in adults when the distal radius growth plate was closed, and so children were excluded from Medoff's study. That study was conducted on 40 patients (20 men and 20 women) between 19 and 85 years old, while the present study included 40 men and 40 women who were above 20 years old. Comparison of the indexes between Medoff's and the present study

is presented in (Table 3). As (Table 3) depicts, distal radius radiological indexes in the present study were significantly different from those of the study by Friberg and Lundstorm.<sup>14</sup> In the present study, children with open growth plate were also taken into account. None of the studies revealed significant differences between males and females [Table 3]. Only UV can be measured in the below 20-year-old age group, since none of the previous studies have established validated radiological indexes for measuring in this age group. In the present study, no significant difference was found between the parameters in the above 20-year-old age groups. Nonetheless, a significant difference was observed between the below 20-year-olds and above 20-year-old age groups regarding UV. Thus, in interpretation of wrist radiological indexes, patients in the below 20 and above 20 groups should be compared separately. The study results revealed no significant differences between the two sexes in any of the age groups. This shows that in spite of the effect of sex and age on distal radius microstructure and males' safety against age-related wrist fractures in the study by Kholsa et al., no significant difference was observed between males and females in the above 20 age groups regarding distal radius radiological indexes.<sup>15</sup> By increase in age, distal radius microstructure changes considerably in women; however, no changes occur in shape and dimensions of distal radius in males and females. In general, ulna growth plate is closed at 16 years in females and 17 years in males. Also, distal radius growth plate is closed six months later than the ulna growth plate. Therefore, it is best to categorize for interpretation of distal radius radiological parameters in girls at 16.5 and boys at 17.5 years of age. In this way, UV can be measured in these ages and other parameters can be evaluated and compared in higher ages. Descriptive investigation of the data showed that in the below-20-year-old age groups, there were more negative cases of UV in the children of lower ages, particularly 10-year-olds, and it arrived closer to zero as they became closer to skeletal maturity. This implies that as age increases from birth to skeletal maturity, the maximum longitudinal growth of distal ulna increases compared to distal radius. It may result from the ulna being longer than the radius or distal radius growth plate being more responsible for the distal forearm compared to distal ulna growth plate, which needs further investigation.<sup>16,17</sup> This study has some limitations. We did not record any sporting activity or possible work which may influence distal radius growth until maturity. Also, we did not get a random sample from our index study population.

### Conclusion

We concluded that there is significant ulnar variance change toward less negative ulnar variance with aging until maturity.

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