RESEARCH ARTICLE

Normal Age-Related Alterations on Distal Radius Radiography

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Abstract

Background: The present study was designed to ascertain serial changes on distal radius radiographic parameters attributable to aging.

Methods: In this prospective study, the sample consisted of 120 healthy individuals who were divided into four age groups each containing 15 males and 15 females. In the two below-20-year-old groups, only ulnar variance could be investigated. Wrist radiography was taken and then parameters of the distal radius were measured and compared based on age and sex.

Results: Average UV was -2.48 mm and -1.6 mm in the 2-9 and 10-19-year-old age groups, respectively. Also, in the two above-20-year-old groups, the average radial inclination (RI), palmar tilt (PT), radial length (RL), and UV was 23.7°, 12.4°, 10.5 and +1.1 mm, respectively. Considering ulnar variance, no significant difference was found between the 2-9- and 10-19-year-old groups, as well as among the two above-20-year-old groups. However, a significant difference was observed between the below 20 and above 20 groups. The study results showed no significant differences between males and females in any of the study groups.

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

Key Words: Age, Palmar tilt, Radial inclination, Radial length, Ulnar variance

Introduction

Recent studies have shown significant age-related changes of the bone microarchitecture in distal radius specimens (1, 2). The wrist is repeatedly loaded and is in a location that incurs microstructural changes with aging. However, to date, the effect of aging on the macroarchitecture of the distal radius has not been investigated. Hence, normal anthropometric evaluation of the wrist and identification of variations according to age and gender are useful in evaluating surgical procedures, following-up wrist abnormalities and in designing wrist implants.

The purpose of the present study was to investigate the age and gender-related variability and changes of distal radius indexes.

Materials and Methods

Study design

In this cross-sectional prospective study on 120 healthy individuals, we investigated the radiological distal radius index changes between four age groups.

Data collection

The study population included 120 normal subjects who were equally divided into four age groups of 15 males and 15 females according to age and sex (2-9 years, 10-19 years, 20-49 years, and above 50). 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.

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All procedures were in accordance with the ethical standards of the Committee on Human Experimentation (institutional and national) and with the Helsinki Declaration of 1975, revised in 2008 (3). 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 (4). 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 (4). AGFA CR 85-X digital radiography device (Shimadzu, Kyoto, Japan) was used in this study.

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 (5).

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.

All the statistical analyses were performed using SPSS 12 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 23.78°, 12.48°, and 10.5 mm, respectively. Also, the average UV was +1.1 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 10-19-year-olds was -2.36 and -0.83, respectively, and the difference was not statistically significant [Table 2].

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 Medoff regarding RI and PT (6). 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 30 men and 30 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 (7). 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

Table 1. The mean of RI, PT, RL, and UV

	RI	PT	RL	UV
2-9	-----	-----	-----	-2.48
10-19	-----	-----	-----	-1.6
20-29	23.9	12.9	10.9	0.85
30-39	24.2	13.1	11.1	1.1
40-49	23.6	12	9.9	1.35
≥50	23.67	12.3	10.4	1.07
P.value	0.965	0.884	0.742	0.000

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

	Men	Women	*P*.value
RI	24.0	23.6	0.563
PT	12.4	12.6	0.668
RL	11.5	11.48	0.193
UV	-0.3	-0.5	0.523

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	23.60±2.50 (*P*.value:0.757)	11.20±4.60 (*P*.value:0.124)	11.60±1.6 (*P*.value:0.023)	- 0.6±0.9 (*P*.value:<0.001)
Present study	23.78±3.04	12.48±3.62	10.52±2.65	1.1±1.54
Friberg's study	25± 2.2 (*P*.value:0.013)	9.3± 2.7 (*P*.value:0.001)	12.8± 2.3 (*P*.value:0.001)	-0.13± 1.58 (*P*.value:0.000)

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 (8). 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 (9, 10). 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.

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