Evaluation of normal ranges of wrist radiologic indexes in Mashhad population

ABSTRACT:

Background: The current study aims to measure the normal wrist indexes in our area, compares it with other present databases and discovers the factors may influence radiographic normal indexes.

Methods: 100 healthy participants enrolled in this prospective and cross-sectional study. After performing PA or lateral radiographs, all radiological wrist indexes including first and third metacarpal length, wrist height, ulnar variance, radial tilt, radial inclination, radiolunate angle, capitolunate angle, scapholunate angle, capitate and scaphoid length, lunate and wrist width and Lunate diameter were measured.

Results: Regarding gender, statically significant differences was measured in first and third metacarpal length, wrist height, radial tilt, radiolunate angle, capitate and scaphoid length, lunate, and wrist width, lunate length, and Lunate diameter. The significant linear correlation was measured between ulnar variance, scapholunate angle, wrist width and length with age.

Conclusion: Our study is useful to obtain radiographic normal values of hand and wrist regarding morphological differences among Iranian.

BACKGROUND:

Plain radiograph has been known as the most common instrument to recognize the wrist pathologic disorders (1). For instance, radial inclination, ulnar variance, and radial tilt have been used either to diagnose stability of distal radius fracture or to evaluate the effectiveness of reduction (1, 2). Also, the different ulnar variance is a red flag for wrist disorders such as Kienbock's disease, ulnar abutment and radioulnar impingement syndrome(3). Radial inclination and palmar tilt use to access distal radial fractures outcome(3). Carpal height ratio and scapholunate angle determine wrist collapse and instabilities as a result of rheumatoid arthritis or the avascular necrosis of lunate called Kienbock's disease(4).

The anatomical variations of the wrist have been found among different genders and races and it is a need to define normal ranges in each area (1). This anatomical dissimilarity leads to variability in present normal databases(4).

The current study aims to measure the normal wrist indexes in our area, compares it with other present databases and discovers the factors may influence radiographic normal indexes.

METHODE:

100 healthy participants enrolled in this prospective and cross-sectional study, conducted in three hand clinics in Mashhad, after ethical board approval. Due to Jafari's study sample size calculation was performed considering alpha equals 0.05 with the 80% power for 100 participants (2).

Participants were chosen from the patients' relatives who have been referred to our clinics. healthy participants were asked to take a standard posteroanterior (PA) and lateral wrist

radiographs in our clinic. Exclusion criteria followed as: age under 18, anatomical deformity of upper extremities and recent or previous wrist fractures.

A standard wrist PA view took by placing the beam vertically to radius styloid while the shoulder is 90 degrees abducted and elbow 90 degrees flexed. For lateral view wrist was flexed and abducted while it was in neutral position. To measure radiological indexes, we used Dicom viewer application. All length measured in millimeter and the angles measured in degree. Radiological wrist indexes including first and third metacarpal length, wrist height, ulnar variance, radial tilt, radial inclination, radiolunate angle, capitolunate angle, scapholunate angle, capitate and scaphoid length, lunate and wrist width and Lunate diameter were measured as follow:

Wrist ratio: It is the ratio between wrist height and third metacarpus.

Third metacarpal length: in PA radiograph of the wrist, the interval between distal and proximal articular surfaces measured as third metacarpal length (Figure 1_a).

Wrist height: in PA radiograph, the interval between bases of the third metacarpus to the intersection of the distal articular surface of radius along with third metacarpus alignment were measured as wrist height (Figure 1_ b).

First metacarpal length: in PA radiograph of the wrist the interval between distal and proximal articular surfaces in millimeters measured as third metacarpal length (Figure 1_c).

Ulnar variance: the distance between distal articular surfaces of ulnar and radius which may be considered as neutral, positive or negative variance (3) (Figure_2).

Radial tilt: the angle between volar and dorsal articular ends of distal radius drawn perpendicularly to the longitudinal axes of the radius bone in lateral view (2)(Figure_3).

Radial inclination: the angle between two lines, one drawn a perpendicular to the longitudinal axis of the radius and the other one from radial styloid to ulnar aspect of distal of the radius in PA radiograph(1) (Figure_4).

Radiolunate angle: the angle between longitudinal axes of radius to longitudinal axes of lunate in lateral view (5). (Figure_5).

Capitolunate angle: the angle between longitudinal axes of capitate to lunate axes in lateral view (5) (Figure_6).

Scapholunate angle: the angle between longitudinal axes of lunate and scaphoid (tangential line from the dorsum of scaphoid) in the lateral radiograph (5) (Figure_7).

Scaphoid length: the interval between distal and proximal poles of scaphoid bone in millimeters in wrist PA radiographs (Figure_8_S).

Capitate length: the distance between the distal and proximal pole of the capitate (Figure_8_C).

Lunate width: maximum diameters of lunate bone prolonged to radius alignment in wrist AP radiographs (Figure_8_L).

Wrist width: the distances between ulnar side articular corners of the 5^{th} metacarpus to the radial corner of the second metacarpus in PA view (Figure_8_W).

Lunate diameter*:* maximum lunate diameter which is parallel with radius bone in lateral view (Figure_9).

Data were analyzed by SPSS version 16.0 (SPSS Inc., Chicago IL) and P-value more than 0.05 was assigned as significant. Leven's test, T- test and Pearson correlation were used to analyze data and to investigate the relationship between variables.

RESULTS:

A total of 100 participants enrolled in our study, 47 were women and 53 were men. Also, 61 participants were right-handed and 39 were left-handed. The mean age of participants estimated as 38.1± 14.7 years with the maximum of 85 and minimum 18 years old (Table- 1).

The mean of first and third metacarpal length were 49.7± 3.95 and 70.1± 5.55, respectively. The mean of wrist height was 37.1± 3.75, ulnar variance was 1.15± 2.54, radial tilt was 10.2± 5.17, radial inclination was 24.5± 3.23, radiolunate angle was 3.31± 9.02, capitolunate angle was 18.3± 6.99, scapholunate angle was 52.5± 8.92, capitate length was 23.8± 2.39, scaphoid length was 23.1± 3.57, lunate width was 10.9± 1.51, wrist width was 46.7± 4.77 and Lunate diameter was 9.63± 1.25 (Table-2).

Regarding gender,statically significant differences was measured in first and third metacarpal length, wrist height, radial tilt, radiolunate angle, capitate and scaphoid length, lunate and wrist width, lunate length and Lunate diameter (Table-3).

Significant linear correlation was measured between ulnar variance, scapholunate angle, wrist width and length with age (Table-4).

DISCUSSION:

Nowadays several imaging studies have been provided to measure bony structures using landmarks on PA and lateral radiographs (1). Normal wrist indexes can be useful to follow up

hand pathologies by comparing indexes before and after treatment (6). Considering race, age and gender differences in radiograph analysis have been recommended since they affect diagnose accuracy (1, 7).

Like every other study, our study has some limitation. One of the limitation was the risk of inaccurate measuring owing to operator related technique for performing radiographs. The second limitation was that we used patients' healthy relative which may not really representative of the normal Iranian population. Finally, due to the limited time and budget we had to reduce the number of participants to the minimum calculated number which was 100.

The fact that age and gender influence hand indexes such as ulnar variance, third metacarpal length, and radial inclination have been proven in Mexican, Egyptians and Taiwanese population before (1, 7, 8). Also, Okan et al. revealed differences in the carpal height, carpal- ulnar distance and third metacarpal length among various ages (9). As we measured ulnar variance is in correlation with age that implies it as a cause of ulnocarpal impingement syndrome(10). Moreover, normal aging is in combination with degenerative changes (1). Unlike the results of our study, Mohammed Ali et al. in their study reported that ulnar variance varies between males and females (1). Despite the ulnar variance, the other length related indexes were significantly shorter in women implying that men wrist are wider.

Jafari et al results and our results are similar in a number of ways. Just like our study, Jafari et al. revealed no significant different in radial tilt and scapholunate angle due to age and sex, no significant different in ulnar variance and radial tilt regarding sex and age, respectively. Also, Wrist height, third metacarpal length, lunate width, and capitate length found to be statically different considering gender(2). Comparison between our study and Jafari study showed in table_5.

On the controversy, carpal height ratio was not statically significant due to age in Wang et al. study (7). Neither age nor gender affected wrist radiographic indexes in Foteva el al study(11).

One important distinction between Jafari el. al and our study is that no significant different found in wrist height, third metacarpal length, lunate width and capitate length considering age. Also, carpal height ratio were not statically significant due to age and gender in Jafari el. al. study; however, in our study wrist height was significantly higher in females and found to be decreased by aging(2).

Finally, it is a common knowledge which radiographic instruments can use to perform new orthopedic studies, make orthopedic implants and diagnose pathologic disorders such as carpal collapse caused by osteonecrosis or osteoarthritis, radius fracture and its prognosis, ligament injuries, and make a the most effective decision to perform surgical procedures (2, 3, 6, 12).

CONCLUSION:

Our study evaluates the relationship between age and sex with normal radiograph indexes of wrist among the Iranian population. Different types of studies like ours are useful to obtain radiographic normal values of hand and wrist regarding morphological differences among various races. We recommend that every population should use its database as a normal reference, owing to differences have been found in our study.

Patient consent: informed consent was obtained from the study participant

Disclosure: The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

LEGENDS:

Figure_1: A: Third metacarpal length. B: Wrist height. C: First metacarpal length

Figure_2: Ulnar variance

Figure_3: Radial tilt

Figure_4: Radial inclination

Figure_5: Radiolunate angle

Figure_6: Capitolunate angle

Figure_7: Scapholunate angle

Figure_8: S: Scaphoid length. C: Capitate length. L: Lunate width. W: Wrist width

Figure_9: Lunate diameter

REFERENCES:

1. Mohammed Ali MH. A normal data-base of posteroanterior radiographic measurements of the wrist in healthy Egyptians. Surgical and radiologic anatomy : SRA. 2009;31(9):665-74.
2. Jafari D, Taheri H, Shariatzade H, Mazhar FN, Jalili A, Ghahramani M. Radiographic indices in one hundred fifty normal Iranian wrists. Medical journal of the Islamic Republic of Iran. 2012;26(3):132-9.
3. Mann F, Wilson A, Gilula L. Radiographic evaluation of the wrist: what does the hand surgeon want to know? Radiology. 1992;184(1):15-24.
4. Feipel V, Rinnen D, Rooze M. Postero-anterior radiography of the wrist. Normal database of carpal measurements. Surgical and radiologic anatomy : SRA. 1998;20(3):221-6.

5. Roh YH, Noh JH, Lee BK, Baek JR, Oh JH, Gong HS, et al. Reliability and validity of carpal alignment measurements in evaluating deformities of scaphoid fractures. Archives of orthopaedic and trauma surgery. 2014;134(6):887-93.

6. Schuind FA, Linscheid RL, An KN, Chao EY. A normal data base of posteroanterior roentgenographic measurements of the wrist. The Journal of bone and joint surgery American volume. 1992;74(9):1418-29.

7. Wang YC, Tseng YC, Chang HY, Wang YJ, Chen CJ, Wu DY. Gender differences in carpal height ratio in a taiwanese population. The Journal of hand surgery. 2010;35(2):252-5.

8. Franco-Valencia M, Torres-Gonzalez R, Fuentes-Figueroa S. [Radiographic measurements of the wrist in healthy Mexicans]. Cirugia y cirujanos. 2006;74(5):335-42.

9. Okan N, Caboglu F, Mertoglu T, Durakbasa O, Gorgec M. [The measurement of wrist kinematics in children 4 to 16 years old and the comparison of the scapholunate distance with adult values]. Acta orthopaedica et traumatologica turcica. 2004;38(1):30-3.

10. Nakamura R, Tanaka Y, Imaeda T, Miura T. The influence of age and sex on ulnar variance. The Journal of Hand Surgery: British & European Volume. 1991;16(1):84-8.

11. Foteva M, Poposka A. KINEMATIC RADIOGRAPHIC MEASUREMENTS OF THE WRIST IN THE HEALTHY POPULATION IN THE REPUBLIC OF MACEDONIA. Prilozi/Makedonska akademija na naukite i umetnostite, Oddelenie za biološki i medicinski nauki= Contributions/Macedonian Academy of Sciences and Arts, Section of Biological and Medical Sciences. 2010;31(2):83.

12. Schuind F, Alemzadeh S, Stallenberg B, Burny F. Does the normal contralateral wrist provide the best reference for X-ray film measurements of the pathologic wrist? The Journal of hand surgery. 1996;21(1):24-30.

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