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Research Article

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Distal Radius Morphometry in the Saudi Population

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Abstract

Objectives: This research paper aims to investigate the morphometric parameters of the distal radius in the Saudi adult population and to compare these findings to the international standards, a total of 389 participant have been included. The specific objectives are to determine gender and side-specific differences in volar tilt, radial height, and radial inclination and to analyze the values of these parameters.**Methods:** A retrospective descriptive cross-sectional study was conducted at King Abdulaziz Naval base, Armed Forces Hospital in Jubail, Saudi Arabia. Wrist radiographs of 389 participants were evaluated. Statistical analysis was performed using SPSS, including descriptive statistics, independent t-tests, and calculation of means, standard deviations, and ranges.**Results:** The mean volar tilt was 13.28° (SD ± 3.03°), radial height was 12.41 mm (SD ± 2.05 mm), and radial inclination was 22.93° (SD ± 3.47°). Significant differences were found in radial height between males and females ($p < 0.05$) and between the right and left sides ($p < 0.05$) for both radial height and radial inclination.**Conclusion:** This study provides valuable data on the morphometric parameters of the distal radius in the Saudi adult population. Significant variations were observed in volar tilt, radial height, and radial inclination between genders and between the right and left sides. No significant variations have been found between our population and the international standards. These findings have important implications for clinical practice and treatment decisions, highlighting the need for population-specific reference values.

Keywords: Distal Radius; Morphometry; Volar Tilt; Radial Height; Radial Inclination; Saudi Population.

Introduction

Distal radius morphometry plays a crucial role in the clinical assessment and treatment of wrist fractures. Accounting for a significant proportion of all upper limb fractures, distal radius fractures present a common challenge in orthopaedic practice [1,2]. Additionally, understanding the normal values of distal radius morphometry is essential for achieving successful outcomes. Furthermore, positive ulnar variance has been identified as a potential risk factor for the development of Kienbock's disease [3]. (Figure 1) showing normal value measurement of the distal radius and how its measured [4].

The intricate interplay between distal radius morphometry and wrist biomechanics has been the focus of previous investigations [5]. Among the key morphometric parameters, palmar tilt, radial inclination, radial height, and ulnar variance have emerged as critical determinants. In a pioneering cadaver study conducted by Short et al. in 1987, the significance of palmar tilt was demonstrated. Increased dorsal angulation was found to elevate the load transmitted through the ulna, leading to concentrated pressure distribution on the ulnar and radial articular surfaces.

Similarly, the effects of radial shortening and decreased radial inclination have been extensively documented [6]. The evaluation of distal radius morphology using anterior-posterior and lateral wrist radiographs have faced significant criticism from certain authors who question its reliability and limited reproducibility. One of the major challenges associated with this radiological assessment method is accurately determining the radial axis in the anterior-posterior view [4,7,8]. In recent years, several studies have highlighted the impact of even slight rotational variations in wrist positioning during radiography on these measurements. These variations have the potential to negatively influence treatment decisions. Recognizing racial disparities in distal radius morphometry is also important, as different populations have been found to exhibit distinct characteristics in this regard [8,9].

Unfortunately, in the context of clinical practice in Saudi Arabia, the reliance on Western figures for reduction is to investigate the morphometric parameters of the distal radius in the Saudi adult population. By conducting techniques is common due to the lack of comprehensive local database. This knowledge gap underscores the need to establish population-specific normative values to guide clinical decision-making accurately. Therefore, the aim of this study a systematic examination and measurement of these parameters, we seek to contribute valuable data that can enhance the precision and efficacy of distal radius fracture management in our local context. The findings of this study will provide orthopaedics surgeons in Saudi Arabia with a tailored reference for restoring anatomical alignment and optimizing treatment outcomes. By bridging this knowledge gap and shedding light on the morphometric characteristics of the distal radius in the Saudi population, we anticipate that our research will significantly impact clinical practice, leading to improved patient care and better-informed treatment decisions (Figure 1).

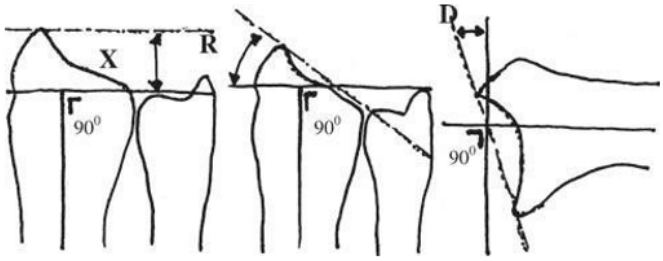

Figure 1: Normal value measurement of the distal radius and how its measured [4], Radial Hight X= 11mm, Radial inclination R= 22°, Volar tilt D=10°.

Methods

Study design and Setting

Retrospective single-facility-based descriptive cross study was carried out at King Abdulaziz Naval base, Armed Forces Hospital (KANB-AFH) in Jubail, Saudi Arabia.

Instrument

Consecutive wrist radiographs of patients who presented with wrist related complaints at the emergency unit, FCM and OPD during the study period were evaluated.for in seek of authenticity and to avoid the inter observer error , all the morphometric measurements were done by a single independent personnel.

Sample size and sampling technique

We used the following equation in calculating the sample size

$n= N/1+N(e)^2$

where N = population size = 505,162 which is the total population for the Jubail city e = Level of precision

n= Sample size = 390

we used simple randomized sampling technique in sample selection.

Inclusion and exclusion criteria

We have included radiographs with standard radiographic protocol (true anterior-posterior and lateral) of the wrist in this study. Also, we included wrists with fused physeal plates only and excluded the others.

We excluded the entire wrist x-rays of the unossified bone and showing the irregularities due to structural deformity, injured distal end radius, and pathological conditions (i.e., arthritis) because they could have been responsible for the mismeasurement. Furthermore, Films that are rotated or not centered on the wrist have been excluded.

Ethical consideration and data collection

The study followed the principles of the Helsinki Declaration and was approved by the ethical committees of King Abdul Aziz Naval base, Armed Forces Hospital and the Directorate of Health Affairs, Jubail City, Saudi Arabia. The data were collected between January 2018 and January 2021.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS version 23.0) IBM Corp., Armonk, NY, USA was used to enter, edit and analyse the data. We calculated the percentage of each category of the social and demographics variables. We also calculated mean, standard deviation and range of for the volar tilt, radial height, and radial inclination variables Comparison of means has been carried out by using the independent t-test with significance set at $p < 0.05$.

Results

A total of 389 participants were included in the study, with complete data available for age, gender, volar tilt, radial height, and radial inclination. The mean age of the participants was 32.30 years (SD ± 11.48), ranging from 18 to 82 years old. In terms of gender distribution, 75.3% (n = 293) of the participants were male, while 24.7% (n = 96) were female. When comparing both genders, a statistically significant difference was found in radial height. The mean radial height was 12.68 mm (SD ± 2.00 mm) for males and 11.60 mm (SD ± 1.99 mm) for females.

Regarding volar tilt, the mean measurement was 13.28°, with a standard deviation of ±3.03°. The observed range of volar tilt values observed in the sample ranged from 2.900° to 29.930°. For radial height, the mean value was 12.41 mm, with a standard deviation of ± 2.05 mm. The range of radial height measurements spanned from 6.91 mm to 22.55 mm. As for radial inclination, the mean measurement was 22.93°, with a standard deviation of ±3.47°. The range of radial inclination values ranged from 10.15° to 33.21°.

When comparing the right side and the left side, a statistically significant difference was observed in radial height and radial inclination. For radial height, the mean measurement was 12.6842 mm (SD ± 2.00 mm) on the right side and 11.6093 mm (SD ± 1.99 mm) on the left side. Regarding radial inclination, the mean measurement was 22.9919° (SD ± 3.44°) on the right side and 22.7472° (SD ± 3.57°) on the left side.

The results of the independent t-tests indicated a statistically significant difference for radial height when comparing between genders ($p < 0.05$), and for both radial height and radial inclination when comparing between the right and left sides ($p < 0.05$). These findings demonstrate significant variations in radial height and radial inclination between genders and between the right and left sides. These differences have significant implications for understanding the anatomical characteristics and potential clinical implications in the studied population (Tables 1,2 & 3).

Parameter	Mean ± SD (range)
RADIAL HIGHT	12.41 mm ±2.05 mm (6.91-22.55 mm)
RADIAL INCLINATION	22.93° ±3.47° (10.15° - 33.21°)
VOLAR TILT	13.28° ±3.03° (2.90° - 29.93°)

Table 1: Distribution of volar tilt, radial inclination and radial height, in n=389 subjects.

Parameter	Males mean ± SD	Female mean ± SD	P-value
RADIAL HIGHT	12.68 mm ± 2.00 mm	11.60 mm ± 1.99 mm	<0.05 (0.001) (Significant statisticaldifference)
RADIAL INCLINATION	22.99° ± 3.44°	22.74° ± 3.57°	>0.05 (No statisticaldifference)
VOLAR TILT	13.14° ± 3.10°	13.70° ± 2.79°	>0.05 (No statisticaldifference)

Table 2: Distribution of morphometric parameters (Mean ± standard deviation) in genders.

Parameter	Left Side mean ±SD	Right Side mean ± SD	P-value
RADIAL HIGHT	12.78 mm ± 2.08mm	12.00 mm ± 1.94mm	<0.05 (0.001) (Significant statistical difference)
RADIAL INCLINATION	23.71° ± 3.36°	22.04° ± 3.38°	<0.05 (0.001) (Significant statistical difference)
VOLAR TILT	13.22° ± 2.95°	13.35° ± 3.12°	>0.05 (No statistical difference)

Table 3: Distribution of morphometric parameters for left and right side.

Discussion

Fractures of the distal radius that cause a loss of the normal downward angulation of the wrist result in increased stress on the joints between the ulna and carpal bones, as well as the joint between the radius and the scaphoid bone [10].This increased stress is primarily concentrated along the back part of the joint. It is established that these heightened loads contribute to pain and, over time, can lead to the early development of joint degeneration. Therefore, it is recommended to strive for a precise realignment of all distal radius fractures in order to restore the normal anatomy. In cases where a fracture has healed in a misaligned position with dorsal angulation, considering an osteotomy may be necessary to reduce the abnormal stresses on the joint between the distal radius and the ulna and carpal bones. Thus, the normal values of volar tilt, radial height, and radial inclination need to be known for orthopaedic surgeons who are practicing in a specific population, Saudi Arabia in our case [6].

Moreover, the findings emphasize the role of distal end radius morphometry in determining the clinical outcomes of wrist injuries. In our study, we did not measure the ulnar variance, as it is not significant in assessing the quality of reduction. It plays a role in other wrist pathologies like Kienbock disease but not in distal radial fracture [11,12].

As described in the results section, the mean volar tilt was 13.28° with a standard deviation (SD) of ± 3.03°, while the mean radial height was 12.41 mm (SD ±2.05 mm), and the mean radial inclination was 22.93° (SD ± 3.47°). (Table 4) will show the comparison between our findings and other previously published studies.

Parameter	Our study	Mishra (11)	A. Hadi (12)	Chan (3)
RADIAL HIGHT	12.41 ± 2.05 mm	11.31 ± 4.9 mm	11.31 ± 1.66 mm	Not reported
RADIAL INCLINATION	22.93° ± 3.47°	23.27° ± 7.42°	23.99° ± 3.75°	25.1° ± 3.42°
VOLAR TILT	13.28° ± 3.03°	10.07° ± 5.28°	13.76° ± 4.36°	12.6o° ± 3.55°

Table 4 : Comparison between this research and other previously published studies.

As we can see, there is a significant difference between the groups, thus strengthening the point that different populations have different distal end radius measurements. When comparing our finding with normal values stated by Vaneerten back in 2007 they found that the normal values were 11 mm for radial length 22° for radial inclination and 10° for volar tilt , which mean no significant difference was found between our findings and the international values [4].

We have found a significant statistical difference in terms of radial height between the two genders and no significant statistical difference in terms of radial inclination and volar tilt. This result is consistent with what Mishra and A. Hadi found [11,12], talking about the distribution of morphometric parameters for the left and right sides, we found a significant statistical difference in the radial height and radial inclination parameters, which is similar to what A. Hadi have found [12] and with N Hollevoet [13] The only difference is that they found a significant statistical difference also in terms of volar tilt, and we didn't Gartland and Werley's cadaveric studies in 1951 introduced a widely used clinical scoring system for assessing distal radius fracture outcomes. Their study of sixty cases revealed that 31.7% experienced unsatisfactory results, with a strong correlation between dorsal tilt and clinical outcome. Interestingly, the loss of radial inclination did not have a significant impact on the final outcomes. Altissimi's 1984 study on 297 wrists undergoing conservative treatment for distal radius fractures also yielded noteworthy findings. They found a higher percentage of unsatisfactory results when radial deviation was less than 5°, dorsal tilt exceeded 15°, or the radioulnar index was above 5mm. Furthermore, grip strength was found to be associated with abnormalities in radiographic parameters. Additionally, Taleisnik and Watson discovered a potential link between increased dorsal tilt and midcarpal instability. These studies highlight the importance of translating cadaveric measurements to clinical practice and considering various radiographic parameters for evaluating distal radius fracture outcomes [3,13].

However, it is important to interpret these results with caution due to certain limitations inherent in the study design and methodology. Firstly, the study had a relatively small sample size, which may limit the generalizability of the findings to the wider population. A larger sample size would have provided more robust and representative results. Future studies should aim to replicate these findings in larger cohorts to enhance external validity. Furthermore, the study's cross-sectional design restricts the ability to establish causality or temporal relationships between variables.

Longitudinal studies could be conducted to investigate the changes in volar tilt, radial height, and radial inclination over time, allowing for a more comprehensive understanding of the observed variations. The generalizability, or external validity, of the study results should be carefully considered. The findings provide valuable insights into the studied population, but caution must be exercised when extrapolating the results to other populations with different demographics, ethnicities, or pathologies. Further research involving diverse populations would be necessary to enhance the generalizability of the findings.

Finally, it can be interpreted that there are significant variations in radial height and radial inclination between genders and between the right and left sides. These findings provide important insights into the anatomical characteristics and potential clinical implications in the studied population. The significant difference in radial height between males and females suggests a potential gender-based anatomical variation in this parameter. Additionally, the observed differences in radial height and radial inclination between the right and left sides indicate the existence of side-specific asymmetry.

Conclusion

In conclusion, this study investigated the variations in volar tilt, radial height, and radial inclination among a sample of participants. The results demonstrated significant differences in these morphometric parameters between genders and between the right and left sides. No significant variations have been found between our population and the international standards. These findings have important implications for understanding anatomical characteristics and potential clinical implications. We need further research to validate and expand upon these findings in larger and more diverse populations.

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