Distal Radius Morphometry in the Malaysian Population

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ABSTRACT

The goal of treatment in distal radius fracture is to restore the anatomy of the distal radius, however the criteria currently used to evaluate the quality of reduction are based on Western based published figures. This goal of this study was to investigate whether there are variations in the morphology of the distal radius among the multiracial population of Malaysia. Consecutive normal wrist radiographs of patients who presented to the accident and emergency unit in three major hospitals in Malaysia were measured. . The palmar tilt of the distal radius averaged 12.6o ± 3.55o, and the radial inclination averaged 25.1o ± 3.42o. The ulnar variance averaged – 0.1 ± 1.31mm, 38.4% of the patients had neutral ulnar variance, 28.8% have negative ulnar variance and 32.9% have positive ulnar variance. Our results indicate that distal radius morphometric parameters in the Malaysian population are comparable to Western figures.

Key Words:
Distal Radius, Morphometry, Malaysian population

INTRODUCTION

The interaction between the morphometry of the distal radius and wrist biomechanics has been previously reported. Three of the most important morphometric parameters of the distal radius are palmar tilt, radial inclination and ulnar variance. In 1987, Short *et al,* performed a cadaver study that demonstrated the importance of the palmar tilt. Increasing dorsal angulation was shown to increase the load that passes through the ulna. The pressure distribution in the ulnar and radial articular surface also became more concentrated with increased dorsal angulation [1]. The changes that occur with radial shortening and decreased radial inclination also have been described [2,3].

Distal radius morphometry is an important factor in the clinical setting. Distal radius fractures encompass eight to fifteen percent of all upper limb fractures. Therefore, knowledge of normal values of distal morphometry is important, as one of the aims of treatment for fractures is to restore anatomical alignment [4]. Further, positive ulnar variance is implicated as one of the possible factors that predisposes to Kienbock's disease [5]. Unfortunately, in Malaysian clinical practice, we often base our reduction on western figures, due in part to the absence of a local database. The aim of this study to determine the morphometric parameters of the distal radius in the Malaysian population and to see whether there are differences between the races commonly found in Malaysia.

MATERIALS AND METHODS

This is a retrospective study carried out at three major hospitals in Malaysia from December 2006 to June 2007. Consecutive wrist radiographs of patients who presented with wrist related complaints at the emergency unit of these hospitals during the study period were evaluated. The radiographs were taken using standard radiographic protocol. Only true anterior-posterior and lateral radiographs of the wrist were used in this study. No comparison was made between right and left wrist for each patient. Films that were rotated or not centred on the wrist were excluded. Only wrists with closed physeal plates were included in this study. All radiographs were corrected for magnification and reviewed by a single independent reviewer from each hospital so as to account for inter-observer differences. Parameters evaluated include the radial inclination, palmar tilt and the ulnar variance (Figure 1). The data was analyzed utilizing SPSS statistical software, version 11.5 for Windows. Comparison of means was carried out using the independent t-test with significance set at $p < 0.05$.

RESULTS

Seventy-seven radiographs were analyzed for purposes of this study. There were sixty-four male patients (83.1%) and 13 female patients (16.9%); in terms of racial distribution, the majority of the patients were Malays (38 patients, 49.4%) followed by 21 Indian patients (27.3%), twelve Chinese patients (15.6%) and six from other races. The age range of the patients is from 16 to 67 years of age with a mean of 30.7 ± 11.5 years old.

The mean value of radial inclination was 25.1° ± 3.42° with a range from 16° to 34°. Palmar tilt averaged 12.6° ± 3.55° while the ulnar variance averaged – 0.1 ± 1.31mm. As for ulna variance, 38.4% of patients had neutral variance, 28.8%

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Table I: Distribution of radial inclination, palmar tilt and ulnar variance according to gender

Parameters	Male	Female	p value
Radial inclination (°)	25.1 ± 3.35	24.9 ± 4.02	p > 0.05
Palmar tilt (°)	12.2 ± 3.18	14.3 ± 4.73	p > 0.05
Ulnar variance (mm)	- 0.14 ± 1.24	+ 0.39 ± 1.68	p > 0.05

Table II: Distribution of radial inclination, palmar tilt and ulnar variance according to race

Parameter	Malay	Indian	Chinese	Others
Radial inclination (°)	24.8 ± 3.03	27.0 ± 3.18	24.1 ± 3.77	22.8 ± 3.87
Palmar tilt (°)	12.9 ± 3.78	13.0 ± 3.57	11.8 ± 2.77	10.5 ± 3.15
Ulnar variance (mm)	0.18 ± 1.28*	0.13 ± 0.70	-0.75 ± 1.42*	-0.8 ± 2.14

* significant difference found when comparing Malaysian population to the other populations with $p < 0.05$

Table III: Comparison between this series and other previously published studies

	This study, in Malaysia	Gartland and Werley, 1951 [8]	Altissimi *et al,* 1986 [9]	Schuind *et al,* 1992 [13]	Werner *et al,* 1992 (cadaveric) [3]	Nakamura et al, 1991 [14]
Radial inclination	25.1° ± 3.42°	23o(13°-30°)	16° to 28°	24o (19-29o)	30°	Not reported
Palmar tilt	12.6° ± 3.55°	11°(1°-21°)	0° to 18°	Not reported	6°	Not reported
Ulnar variance	–0.1 ± 1.31 mm	Not reported	- 2.5 to + 3.1mm	-4.2 to 2.3mm	-0.1mm ± 1.4mm	0.20 ± 1.39mm

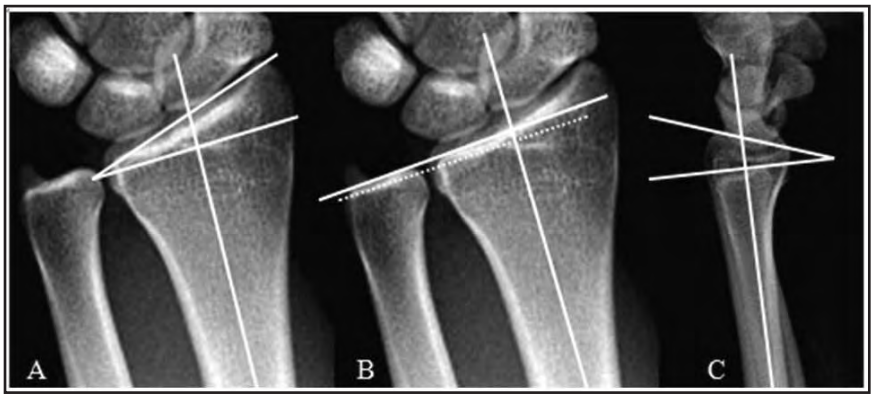

Fig. 1: Radiograph showing method of measurement of radial inclination (A), ulnar variance (B) and palmar tilt (C).

had negative variance while 32.9% of patients had positive variance. The mean radial inclination for both genders was similar. The palmar tilt for female patients was slightly more than male patients (14.3° compared to 12.2° for males). Male patients tended to have a negative mean ulnar variance whereas female patients had positive mean values for ulnar variance. However, these differences were not statistically significant. (Table I).

Among the four races in our series, Indian patients were found to have the highest degree of radial inclination with a value of 27.0 ± 3.18°. Palmar tilt was also greatest in Indian patients with a mean value of 13.0 ± 3.57°. Indian and Malay patients had positive mean ulnar variance whereas Chinese patients and the patients of other races had mean values in the negative range. The only statistically significant difference between these measurements is the ulna variance between the Malays (0.18 ± 1.28) and the Chinese (-0.75 ± 1.42) with $p < 0.05$. (Table II). However these values were small and may not be of clinical significance.

Statistical test were performed to compare the parameters between patients younger than 50y to those older than 50y but no statistically significant differences were found.

DISCUSSION

The correlation between distal radius morphometry and the biomechanics of the wrist have been well established. In 1994, Miyake and colleagues investigated the effects of artificially created dorsal tilt in twenty cadaver upper extremities, and found that in the neutral position, stress was

concentrated at the volar regions of the radio-lunate joint. However, they reported that when dorsal angulation was created, the stress shifted to the dorsal region with increased concentration of stress when the dorsal angulation exceeded thirty degrees [6]. Pogue reported similar findings [7]. Further, Short *et al* demonstrated that change in the stress concentration, from creating a dorsal tilt in cadaveric limbs increased the force transmitted through the ulna, such that at 30°° of dorsal angulation, the ulna load increased to 50% [1]. Other parameters previously evaluated in the laboratory setting include radial shortening, ulnar variance and radial inclination. Adams found that radial shortening created the most distortion to the triangular fibrocartilage complex and caused the greatest disturbance in the kinematics of the wrist. Radial inclination and dorsal angulation caused less change[2]. Werner *et al* also investigated the effects of varying degrees of ulnar variance on the load transmission through the ulnar head and found only a weak correlation between positive ulnar variance and increased load transmission through the ulna [3].

Although the evidence in cadaveric studies was quantitative and objective, it is important to learn how these measurements translates to clinical practice. One of the earliest descriptions of the effects of malunited distal radius fractures is by Gartland and Werley in 1951, and even today, their clinical scoring system is widely utilised in assessing clinical outcomes of distal radius fractures. In their series, out of sixty cases, 31.7% had unsatisfactory results, and a strong correlation was found between dorsal tilt and clinical outcome. In their study, loss of radial inclination had no appreciable effect on the end results [8]. Altissimi et al reported in 1984 that the long term results of conservative treatment of distal radius fractures in 297 wrists. They found a significantly higher percentage of unsatisfactory results when radial deviation was less than 5°, dorsal tilt was greater than 15° or the radioulnar index was higher than 5mm [9]. Grip strength was also related to abnormalities in radiographic parameters [10, 11]. T aleisnik and Watson also found that midcarpal instability could result from increased dorsal tilt [12].

From the above evidence, we conclude that it is quite important to restore alignment of the distal radius to its normal morphology in the event of a fracture. The current practice in Malaysia, often based on Western figures is not optimal. Table III shows that data in other series is comparable to the data in this series. Some factors cannot be controlled in this comparison such as the position of forearm rotation that has been showed by Jung *et al* to significantly alter ulnar variance [15]. Age and gender have also been shown to alter ulnar variance [14].

Weaknesses in this study include the fact that this study contains an uneven distribution of patients in terms of gender and race that may affect comparison of values between gender and race. Being a retrospective study, position of forearm rotation during anterior-posterior radiography may not have been accurate.

CONCLUSION

Results of this study bear out the conclusion that the common morphometric wrist parameters of our population are comparable to those reported in Western society. There was no significant difference in the parameters between gender and major races of this country except for the difference in ulnar variance between Chinese and Malays wrists.

REFERENCES

1. Short WH, Palmer AK, Werner FW, Murphy, DJ. A biomechanical study of distal radius fractures. *J Hand Surg.* 1987; 12A(4): 529-34.
2. Adams BD. Effects of radial deformity on distal radioulnar joint mechanics. *J Hand Surg.* 1993; 18A(3): 492-98.
3. Werner FW, Palmer AK, Fortino MD, Short WH. Force transmission through the distal ulna:Effect of ulnar variance, lunate fossa angulation, and radial and palmar tilt of the distal radius. *J Hand Surg.* 1992; 17A(30): 423-28.
4. Jupier JB, Masem M. Reconstruction of post-traumatic deformity of the distal radius and ulna. *Hand Clin.* 1988; 4: 377-90.
5. Gelberman RH, Salamon PB, Jurist JM, Posch JL. Ulnar variance in kienbock's disease. *J Bone and Joint Surg.* 1975; 57A(5): 674-76.
6. Miyake T, Hashizume HI, Shi Q, Nagayama N. Malunited colles fracture. Analysis of stress distribution. *J Hand Surg.* 1994; 19B(6): 737-42.
7. Pogue DJ, Viegas SF, Patterson RM, Peterson PD, Jenkins DK, Sweo TD, *et al.* Effects od distal radius fracture malunion on wrist joint mechanics. *J Hand Surg.* 1990; 15A(5): 721-27.
8. Gartland JJ, Werley CW. Evaluation of healed colles fractures. *J Bone and Joint Surg.* 1951; 33A(4): 895-907.
9. Altissimi M, Antenucci R, Fiacca C, Mancini GB. Long term results of conservative treatment of fractures of the distal radius. Clin Ortho Relat Res. 1986; 206: 202-10.
10. Jenkins NH, Mintowt-Czyz WJ. Mal-union and dysfunction in colles fracture. *J Hand Surg.* 1988; 13B(3): 291-3.
11. Porter M, Stockley,I. Fractures of the distal radius. Intermediate and end results in relation to radiologic parameters. *Clin Ortho Relat Res.* 1987; 220: 241-52.
12. Taleisnik J, Watson HK. Midcarpal instability caused by malunited fractures of the distal radius. *J Hand Surg.* 1984; 9A: 350-57.
13. Schuind FA, Linscheid RL, An K, Chao EYS. A normal data base of posteroanterior roentgenographic measurements of the wrist. *J Bone Joint Surg*.1992; 74A(9): 1418-29.
14. Nakamura R, Tanaka Y, Imaeda T, Miura T. The influence of age and sex on ulnar variance. *J Hand Surg.* 1991; 16B(1): 84-8.
15. Jung JH, Baek GH, Kim JH, Lee YH, Chung MS. Changes in ulnar variance in relation to forearm rotation and grip. *J Bone Joint Surg.* 2001; 83B(7): 1029-33.