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Original Research Article

Assessment of the Radial Bow in Patients Admitted to the Hospital with Fractures of Forearm Bones

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Abstract:
The human forearm is a unique structure in that the movements of pronation and supination occur at the forearm. This is primarily due to the curved anatomy of the radius which helps it to glide over the ulna. In the anatomical position, the medial cortex of the radius is concave while the lateral cortex is convex. This curve otherwise called the 'radial bow' of the radius, gives the forearm the ability to pronate and supinate resulting in a 'screwing motion'. In our study we aimed to assess the radial bow in a subset of Indian population. This study looked at the amount of radial bow present and its location on the radial diaphysis. We tried to find out whether Gender and Hand Dominance affected radial bow and its location.
Keywords: Radial Bow, Pronation, Supination, Radius, Forearm.

Introduction

The human forearm is composed of two long bones, the radius and the ulna and three articulations, the proximal radio-ulnar joint, the distal radio-ulnar joint and the interosseous radio-ulnar joint. The curved anatomy of the radius is such that it allows the radius to glide over the ulna during pronation [1].

Pronation and supination are the two movements occurring at the forearm. This enables the hand to go from a palm facing forward position to a palm facing backward position. This movement is particularly required to enable activities like writing, picking up objects, feeding oneself, grooming and personal care.

Our study was designed to assess the radial bow in patients who presented to our hospital with forearm fractures. In order to do this, radiographs were taken of the contra lateral normal forearm of these individuals after obtaining prior consent to participate in the study.

When we compare males and females, males in general have a more and better developed muscle mass as compared to females. Whether this difference in physique influenced the amount of radial bowing and/or its diaphyseal location, and if so whether this difference was significant was one of the objectives of this study. We also wanted to find out whether hand dominance affected the magnitude of radial bowing and/or its location in any way. The hypothesis laid down was that since the dominant hand was used more often while performing activities of daily living (like eating, grooming, writing) which required constant pronation and supination of the forearm, the forearm of the dominant hand should have a better developed radial bow than its contra lateral non-dominant counterpart.

As very few studies have been published on the amount and location of the radial bow in the Indian population, our objective was to find out the mean radial bow in a subset of the Indian population and compare it with other studies conducted on the western population.

Materials and method

A prospective study was undertaken in one of the tertiary hospitals in India. Patients with forearm fractures of one side, having an apparently normal contralateral side, were included in the study. There were 43 patients with diaphyseal fractures of the forearm [2,3,4,5,6], 59 patients with distal radius fractures, 4 patients with radial head fractures and 2 patients with olecranon fractures. All these patients showed willingness to participate and consented to be a part of this study. All these patients had a normal contra lateral forearm. This study included both males and females over the age of 21 years.

The assessment of the radial bow was done by taking Antero-Posterior X-rays of the normal forearm in complete supination. 108 patients in all had given their consent to be a part of this study. The X-rays of the normal unaffected forearm were taken during the immediate post-operative period along with the X-rays of the operated forearms. Patients were explained, instructed and guided about the X-ray procedure with special emphasis on the method of placement and positioning of their forearm for the purpose of radiography. To ensure uniformity and reproducibility of the process the following procedure was applied. Patients were instructed to place their normal forearms on the X-ray table with their volar surfaces facing the X-ray beam. They were asked to grip a straight wooden stick in their hand such that the stick was held parallel to the X-ray table. While the patient maintained this position, the radiographer took the X-ray of the normal forearm. This image was saved in the patient's online records. The measurement of the radial bow and its location was done on the computer using the Digital Imaging and Communications in Medicine (DICOM) software (Figure 1).

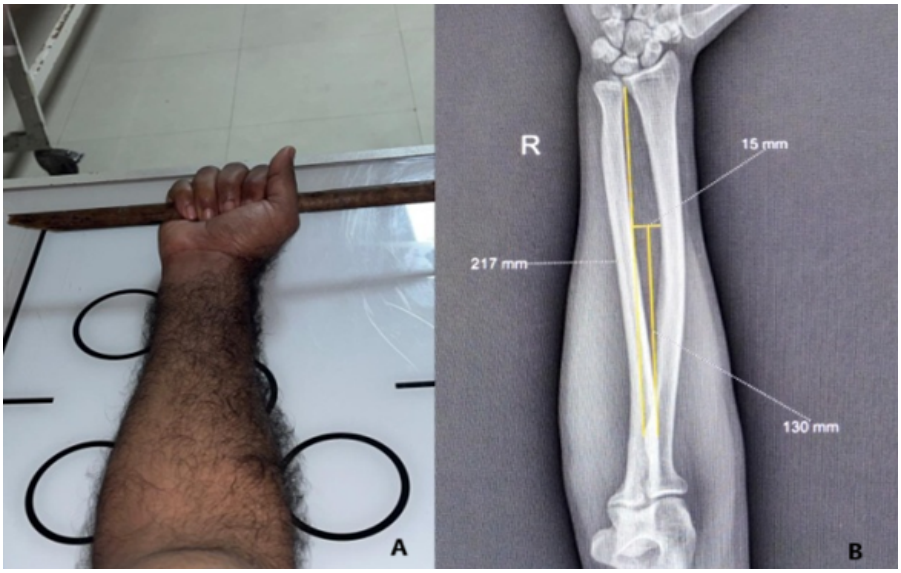

Figure 1: (A) Position of forearm, (B) Calculation of Radial Bow

To assess the radial bow, the method proposed by Schemitsch and Richards was employed [3].

The total length of the radial bow was measured from the prominence of the bicipital tuberosity to the proximal end of the distal radio-ulnar joint on the medial cortex of the radius. The point on the medial radial cortex, at which the concavity of the radial bow was maximum, was identified and a straight line was drawn from there to meet the first line at 90°.

This line provided us the measure of the Maximum Radial Bow (Figure 02).

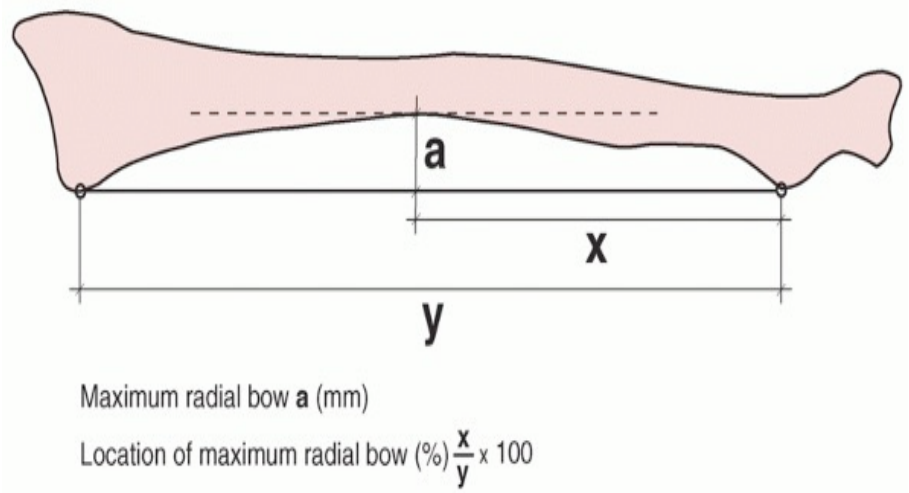

Figure 2: Radial Bow Assessment

The distance from the prominence of the bicipital tuberosity to the perpendicular at the point of the Maximum Radial Bow was measured. This length was divided by the total length of the radial bow and expressed as a percentage. This gave us the Location of the Maximum Radial Bow as a percentage of the total length.

The data obtained was analyzed using SPSS version 20. Frequencies and means were tabulated and Independent-samples T test was used to calculate the significance.

Observations

1. Participants: The study was conducted over a period of one year. The total number of patients included in this study were 108 adults, of these 60 were males and 48 were females.

2. Age: The mean age of the subjects in this study was 40.92(±8.9) years. The mean age of males was 40.92(±9.04) years and the mean age of the female participants was 40.92(±8.73) years.

3. Normal forearm: Among the 108 patients who were included in this study 57(52.8%) had a normal right forearm while 51(47.2%) had a normal left forearm. The number of male patients with a normal right forearm was 36(60%) while the number of females with a normal right forearm was 21(43.8%). 24(40%) male patients had a normal left forearm and 27(56.2%) female patients had a normal left forearm. For the purpose of this study, the measurements of the radial bow were performed on the normal forearms

4. Dominant hand: Among the 108 participants, 96(88.9%) subjects were right hand dominant while 12(11.1%) subjects were left hand dominant. Of these 96 subjects who were right hand dominant, 54 were males and 42 were females, while among the 12 subjects who were left hand dominant, 6 were males and 6 were females. In 96 subjects who were right hand dominant, 50 had their right forearm that was normal while among the 12 subjects who were left hand dominant, 5 had their left forearm that was normal Of the 108 patients who were part of this study it was observed that in only 55(50.9%) of them the uninjured normal forearm was also their dominant side, while in the remaining 53 their dominant side forearm was fractured and their uninjured normal forearm was their non-dominant side. 55 patients in whom the normal forearm was situated on their dominant side, 50(90.9%) were on the right side while 5(9.1%) were on the left side.

Males with normal dominant right forearm were 31(28.7%) and females with normal dominant right forearm were 19(17.6%). There was only one male (0.9%) with normal dominant left forearm, while females with normal dominant left forearm were 4(3.7%). There were 53 participants whose normal forearm was situated on their non-dominant side. Of these there were 7(13.2%) participants whose non-dominant normal forearm was on the right, while 46(86.8%) participants had non-dominant normal forearm that was situated on the left.

The gender wise distribution of non-dominant normal forearm showed that 5(4.6%) males had non-dominant normal right forearm and 23(21.3%) males had non-dominant normal left forearm. Among females 2(1.9%) had non-dominant normal right forearm and 23(21.3%) had non-dominant normal left forearm.

5. Radial bow: The mean radial bow in this study group was 15.3±0.2 mm. Among the male participants the mean radial bow was found to be 15.3±0.2 mm while in the female subjects the mean radial bow was found to be the same i.e. 15.3±0.2 mm. There was no difference in the gender wise distribution of the radial bow.

The mean of the radial bow measured in the normal right forearm of the participants was found to be 15.3±0.2 mm, which was the same as the mean of the radial bow measured in the normal left forearm of the subjects i.e. 15.3±0.2 mm. In the normal forearm of the dominant side, the average radial bow was 15.3±0.2 mm while the mean radial bow on the non-dominant normal side was 15.3±0.2 mm. This finding suggested that hand dominance did not influence the size of the radial bow

Analysis of the radial bow with respect to the hand dominance among males and females did not reveal any significant difference. (Table: 01)

Table 1:

T-Test: Normal Radial Bow		Gender		
		Male	Female	
normal forearm on dominant side	right	15.3±0.2	15.4±0.2	p=0.758
	left	15.5	15.3±0.3	
normal forearm on non-dominant side	right	15.3±0.2	15.1±0.1	p=0.931
	left	15.3±0.2	15.2±0.2	
		p=0.323		

6. Location of the radial bow: The mean location of the radial bow in this study was at 59.9±0.4%. In the male participants the mean location of the radial bow was at 59.8±0.4% and in the female

participants it was at 59.9±0.4%. The mean location of the radial bow in the normal right forearm of the subjects was 59.9±0.4%, while in subjects in whom the location of the radial bow was measured in their normal left forearm, the mean was found to be 59.9±0.4%. The mean location of the radial bow in patients with normal forearms of their dominant side was 59.9±0.4% while the location of the radial bow in patients with normal forearms of their non-dominant side was 59.9±0.4%.

Mean location of the radial bow in patients with right hand dominant normal forearms was 59.9±0.4% while the mean location of the radial bow in patients with left hand dominant normal forearms was 60±0.3%. The difference in the mean location of the radial bow between the right and left side was not found to be significant. Similarly, the mean location of the radial bow in patients with normal forearms on their non-dominant right side was 59.9±0.4% while the mean location of the radial bow in patients with normal forearms on their non-dominant left side was 59.9±0.4%. There was no difference in the mean location of radial bow in the non-dominant right and left forearms.

The analysis of the mean location of the normal radial bow with respect to hand dominance among males and females did not reveal any significant difference either. (Table: 02)

Table 2:

T-Test: Location Of Normal Radial Bow		Gender		
		Male	Female	
Normal forearm on dominant side	right	59.8±0.4	59.9±0.4	p=0.588
	left	59.9	60±0.4	
Normal forearm on non-dominant side	right	59.8±0.5	60.2±0.1	p=0.879
	left	59.9±0.4	59.9±0.4	
		p=0.407		

Discussion:

An optimal radial bow is essential for normal forearm function. Assessing the radial bow enables us to establish a data base for future referencing especially in the Indian population. In our study the total number of males was 60 and females were 48. Studies conducted by Goldfarb et al, Pathan et al, Chapman et al and Leung et al also showed similar pattern with males outnumbering females [2,4,5,6].

Table 3:

Study Name	Gender distribution
Goldfarb et al	Males-14, females-9
Pathan et al	Males-36, females-18
Chapman et al	Males-68, females-19
Leung et al	Males-23, females-9

It was observed that in the age group less than 50 years most of the patients were males in whom fractures of the forearm were as a result of road traffic accidents. In adults more than 50 years, forearm fractures were noted more commonly in females, most of them being as a result of domestic falls at homes. The bone quality is reduced in elderly, especially females, predisposing them to easy breakage following trivial falls.

The method of obtaining X-rays of the forearm of the participants of this study was standardized. A similar method was used by Pathan et al in their study in order to ensure reproducibility and comparability of the measurements obtained [4].

The radial bow assessment was done using the method described by Schemitsch and Richards. In our study the mean radial bow was found to be 15.3±0.2 mm and the mean location of the radial bow was 59.9±0.4%. This was comparable to the results obtained by Schemitsch and Richards in their study wherein they found the radial bow to be 15.3 mm and its location to be at 59.9% on the normal side [3].

However, in the study conducted by Pathan et al the mean radial bow was found to be 11.75 mm and the mean location of the radial bow was 58.73% on the normal side [4].

In our study we found that neither gender nor hand dominance had any significant influence on the magnitude (P=0.323 and P=0.758) and location (P=0.407 and P=0.588) of the radial bow.

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