

## Biokinetic Study of the Wrist joint.

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### ABSTRACT

**Introduction:** Quantification of joint mobility by ROM (range of movement), meaning the maximal range of joint angle, is used to evaluate the degenerative joint disorders and the efficacy of treatment. Age, gender, individual habits, daily activities and tissue degeneration influence the joint ROM. The wrist joint, with many supporting tissues to perform a motion, is a complex structure. Many studies mentioned ROM may be different in various racial groups because of their body built, underlying diseases.

**Objective:** This study aims to establish a database of wrist joint ROM and factors influencing it among Myanmar population.

**Method:** 120 Myanmar volunteers with no past history of musculoskeletal or neural lesions, but with normal functional wrist joints of both sides, were included. 30 subjects (15 males and 15 females) each from 5-17 year, 18-40 year, 41-60 year, 61 year and above age groups participated. Various ranges of wrist joint motions were measured by hand goniometry in pronation position only as most of the daily activities were usually performed in pronation.

**Result:** The average of ROM of wrist-joint flexion was 68.3 degrees, extension was 68.2 degrees, radial deviation was 19.6 degrees and ulnar deviation was 26.1 degrees. Significant difference between male and female was found in ulnar deviation of right side. 5-17 year age group had wider range of motion than other age groups while over 60 people has lowest.

**Conclusion:** The findings highlighted the decline in wrist-joint motion capability with age. If facilities are available, ROM of wrist joint during both pronation and supination should be measured by using electrogoniometer.

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**Keywords:** Range of movement, radial deviation, ulnar deviation, Myanmar , daily activities

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## **Introduction**

Joint flexibility is defined as the range of motion (ROM) allowed at a joint. A range of motion refers to the distance and direction a joint can move to its full potential. ROM is usually measured by the number of degrees from the starting position of a segment to its position at the end of its full range of the movement 1.

The wrist is the anatomic bridge uniting the hand with the forearm which is capable of an impressive arc of motion retaining a remarkable degree of stability. It is a synovial joint of ellipsoidal type. It is an exceedingly complex structure composed of several joints and a dedicated ligamentous system. Its functional principles allow a wide range of carpal motion for functional activities of daily life and make the wrist remarkably resistant to external stress forces: These motions include flexion, extension, ulnar and radial deviation (adduction and abduction) as well as a combined wrist and elbow motion for pronation and supination. The functional range of motion (ROM) requirements are significantly less with 40-degrees of flexion and extension and a 100-degree arc of forearm rotation required for activities of daily living 2. Extension with abduction and flexion with adduction of wrist joint take place in daily works like eating, driving, working, dressing and also hammering nails etc. Individual bony structure and soft tissue mobility as well as injury can all effect the range of motion.

There is considerable difference in the range of all movements between the two hands of the same individual or from individual to individual. It is also influenced by the position of the hand whether it is in pronation or supination. The articular, periarticular pathological conditions and operative procedures of wrist joint would cause restriction of the functional range of motion. The fluctuation in the range of joint motion was especially wide in the infants and the aged persons<sup>3</sup>. The age, gender, individual habits, daily activities and tissue degeneration might influence the joint ROM.

Santos and Cuevas<sup>4</sup> stated that a detailed analysis of the kinematic and dynamics of the wrist is important to understand the effect of orthopedic diseases as well as to design and evaluate rehabilitative and surgical treatments. The objective measurements of joint motion are used as indices of improvement following certain wrist reconstructive procedures. ROM is also useful in workplace ergonomics to help design work stations and equipment like walking support.

Goniometry is the method most widely used to measure range of motion, and its reliability is affected by many factors<sup>5</sup>. In this study the tool used to measure the wrist joint motion was goniometer. This study aims to estimate the functional ROM of wrist joint among selected groups in Yangon, Myanmar and to determine the age and sex differences of wrist joint ROM among studied population

## **Material and Method**

### **Materials**

The study was conducted on 120 Myanmar volunteers of both sexes (60-males and 60-females) of different age groups. All right hand dominant individuals of age 5 years and above with normal functional wrist joints of both sides were included. Any individual who use hands in their occupation like sports players and who had some history of illness or injury involving the wrist joint were excluded from this study. Various ranges of wrist joint motions like flexion,

extension, abduction and adduction were measured by manual flexible double-armed goniometer. The instrument used was 6 inches long with 360° faces. A small scale on one of the arms made it possible to obtain measurements to the nearest degree.

## Methods

A stationary arm, holding a protractor, is placed parallel with stationary body segment and a movable arm moving along a movable body segment. The anatomical landmarks were identified. For measurement of flexion/extension, triquetrum, head of 5th metacarpal bone and olecranon were identified. (Fig 1)

The subject was in the sitting position. Elbow was flexed 90 degree. Forearm was then stabilized on a table or arm of the chair and asked the subject to do active full flexion and extension with finger extended. Note the degrees reading between the end points of the goniometer and record them. For measurement of flexion and extension, axis of goniometer was placed at the lateral wrist (triquetrum). Stationary arm was aligned with ulna (line joining the triquetrum and lateral epicondyle). Moving arm was parallel with longitudinal axis of fifth metacarpal. Measurement of flexion and extension at right and left hands were done (Fig 2 & 3).

Capitate, head of 3rd metacarpal bone and lateral condyle bony marks were identified for measurement of abduction/adduction ROM. (Fig 4)

During wrist radial deviation (abduction) and ulnar deviation (adduction), subject was seated with forearm resting on the table to ensure stabilization and active movements were measured. Goniometer axis was placed over the capitate bone, stationary arm was aligned with forearm (connecting the capitate with lateral epicondyle) and moving arm was parallel to longitudinal axis of the 3rd. of metacarpal bone. Note the degree reading between the end points of the goniometer and recorded them. ((Fig 5 & 6) To avoid intra-observer variations, all measurements were done by only one investigator.

## Results

A total of 120 volunteers were studied out of which 60 were males and 60 were females and the means and SD ROM of flexion, extension, abduction and adduction are presented in Table I.

Fig 7 showed the comparison of mean range of flexion and extension by sides. As the sample included only those who were right handed, the ROM of right wrist joint was reduced in both flexion and extension. But the reduction was not statistically significant. When the abduction and adduction mobility were compared, there was no apparent difference. That was the abduction and adduction ROMs of right and left are almost the same. (Fig 8 )

The comparison of mean ROMs between gender was done. Table 2 showed the mean and standard deviations of ROMs among male and female respondents. The mean values of male and females were almost equal in flexion, extension and abduction movements on both sides. However, in adduction, the mean ROM of female was significantly greater than that of males. That was found only for the right side. On the left side, both males and females appeared to have similar results.

Fig 9 showed the graphs of the ROMs of both wrist joints in relation to age. X axis was the age in years and Y axis was the degree of ROM. The ROMs of flexion, extension and adduction were significantly declined as the age advances. But there was no relationship between age and ROM of abduction movement.

## **Discussion**

Many literatures revealed various ROMs of the wrist joints. In a normal wrist, the total arc of motion averages 150 degrees, there is 80 degrees flexion and 70 degrees extension.<sup>7</sup>

Sinclair<sup>8</sup> reported that extension was rather less than flexion. In this study ROM of flexion and extension was nearly the same. Because of longer styloid process of radius, range of adduction is expected to be more than that of abduction. This study follows the same finding and it was consistent with reports of other studies.

Hewitt<sup>9</sup> described that ROM of right hand was slightly less than the left with the hand supinated and slightly more during pronation<sup>[5]</sup>. But in this study the measurements were done only in pronation. So the difference in ROMs of wrist joint (on supination and pronation of the hand) could not be observed here.

Ryu et al<sup>10</sup> described the difference in ROM of wrist joint measured by hand-goniometer (manual) and electro-goniometer. In the current study, measurements of wrist joint motion were done with use of a universal goniometer (manual goniometer).

In this study, mean ROMs of flexion and extension of left wrist joint were slightly more than the right. This finding was same with description of Allander et al.<sup>11</sup> and Nemethi<sup>12</sup>.

The reduced mobility on the right side was explained by the above authors as the result of slight degenerative changes in the joint as well as damage to the ligaments in the right-handed population. No difference in ROM for abduction and adduction movements was found in this study.

Motamed<sup>13</sup> expressed range of all motions of wrist joints with different age groups and capability of all motions declined with age. This was consistent with the results of this study except right abduction. In this study, there was no gender difference in range of motion of wrist joints except in the ulnar deviation of right wrist joint. As the reports of previous studies did not specify the gender of the subjects, a comparative analysis with previous findings could not be made.

## **Conclusion**

The findings highlighted the decline in wrist-joint motion capability with age. The similar pattern of motion range in both sexes indicated that gender does not play an important role in limitation of wrist joint movement. The similar findings among working and non working females suggested that employment would not usually restrict the wrist joint movements. However, due to limited sample size, further analysis could not be done to compare the difference between manual workers and sedentary workers, or between intellectual and clerical

staff. Further studies would be needed to reveal a relationship between the nature of jobs and the ROM of wrist joints among different age groups. It is advisable for future studies the ROM of wrist joint should be measured during pronation as well as supination of forearm by the use of electrogoniometer.

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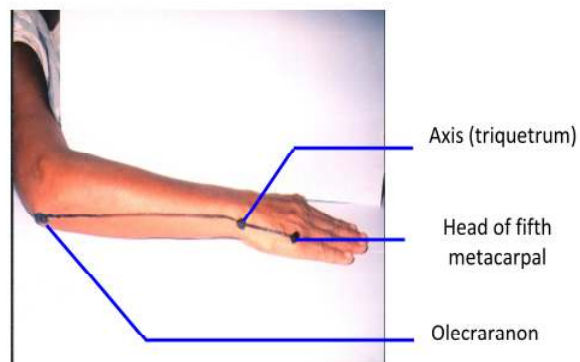
**Table 1: Mean degrees of motions at the wrist joints of 120 volunteers**

Type	degrees of movement
Flexion	68.3 ± 10.6
Extension	68.2 ± 10.3
Abudction (radial deviation)	19.6 ± 5.7
Adduction (ulnar deviation)	26.1 ± 7.6

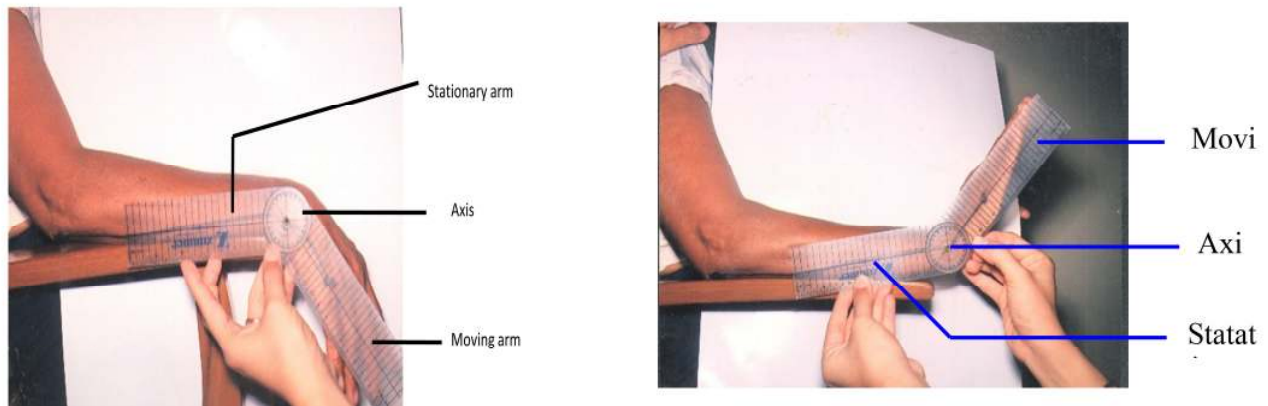
**Table 2: Comparison of mean ROM at wrist joint by gender**

Motions	Side	N	Mean (in degrees)	
			Male	Female
Flexion	Right	60	66.3± 10.24	66.7± 10.6
	Left	60	70.3± 9.23	69.8± 11.9
Extension	Right	60	65.4± 9.6	68.5± 10.7
	Left	60	69.6± 9.1	69.4± 11.2
Abduction	Right	60	19.98± 5.9	19.2± 5.7
	Left	60	19.93± 6.2	19.2± 5.7
Adduction	Right	60	23.8± 6.5	<b>26.7± 8.1</b>
	Left	60	26.63± 7.6	27.1± 7.6

**Figure 1:** Markings in measuring flexion and extension ROM of wrist joint



**Figure 2:** Range of flexion and extension of wrist joint ( right side)

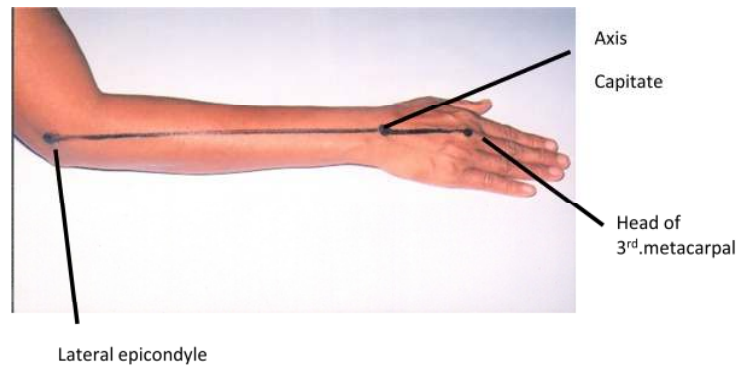


**Fig 3 .**Range of flexion and extension of wrist joint ( left side)

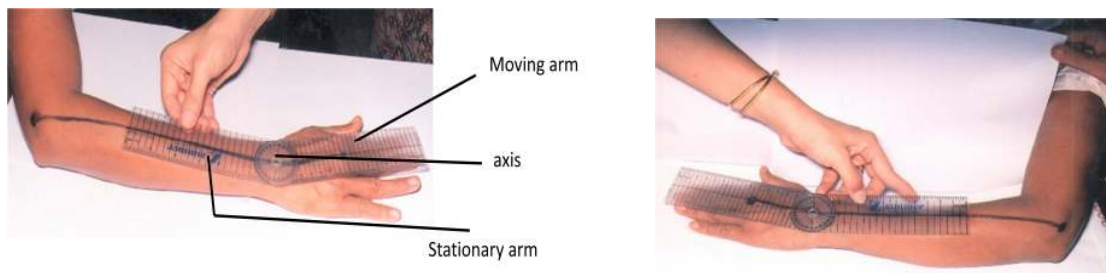




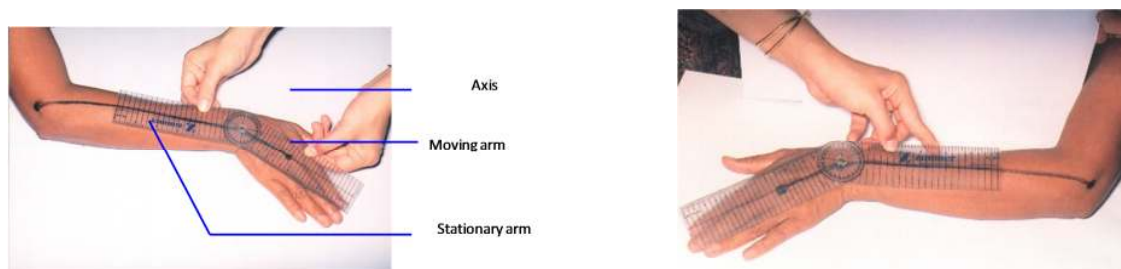
**Fig 4:** Markings in measuring the abduction and adduction ROM of wrist joint



**Fig 5:** Range of radial deviation of right and left wrist joint

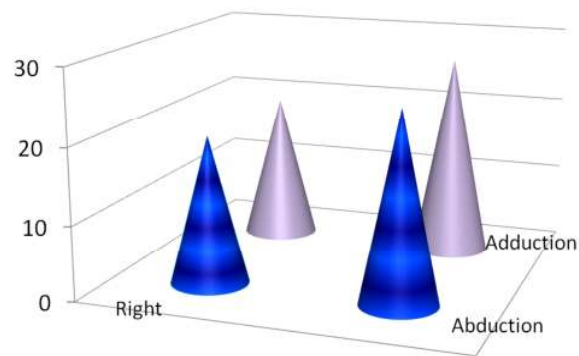


**Fig 6:** Range of ulnar deviation of right and left wrist joint.

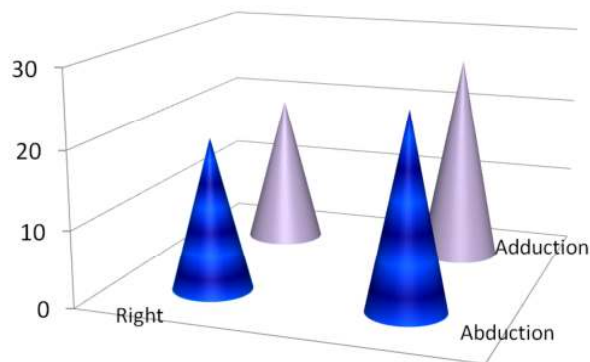




**Fig 7:** Right and Left Comparison of mean ROM for flexion and extension



**Fig 8 :** Comparison of mean ROM for abduction and adduction



**Fig 9:** ROM of wrist joint in relation to age

