

Original Research Article

A Study on Range of Movement (Radial Deviation, Ulnar Deviation, Flexion and Extension) of Wrist Joint

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ABSTRACT

Background: The measurement of joint movement is an important component of a comprehensive physical examination of the all extremities by which one enables health professionals to accurately assess dysfunction and rehabilitative progress.

Aim: To determine the normal range of motion or angle of the joint at Wrist via the performance of active joint motion of the subjects during the evaluation allows the examiner to screen for abnormal movements and gain information about the subject's willingness to move. Resisted isometric muscle contraction and tests are used in conjunction with Goniometry to help isolate the injured anatomical structure.

Materials and Methods: All the subjects (400 Subjects) studied had a normal wrist joint skeleton which was included in the present study. All subjects were divided into four age groups and wrist joint were subjected to goniometric measurements with the movement ulnar and radial deviation and flexion and extension of both hands through universal Goniometer.

Statistical Analysis: Mean and standard deviation of the analyzed parameters taken into account Statistical analyses were performed with the SPSS version 20.

Result: Readings were noted, (the radial & ulnar deviation and flexion and extension) of the wrist joint, total range of motion were higher in left hand as compared to the right hand.

($p < 0.005$). Female subjects showed higher range of motion than the male and joint range of movement decrease with the increase of the age ($r = -0.137$ in right hand and $r = -0.143$ in left hand).

Conclusion: Average range of motion significantly decreases with increasing age, significantly higher in female than in the male and significantly greater in the left hand turn on the right hand.

Keywords: Wrist joint, Range Of Motion, Goniometer,

INTRODUCTION

The measurement of joint range motion is an important component of a comprehensive physical examination of the extremities, which enables consultant to accurately assess dysfunction and rehabilitative progress record.

Goniometry is an important part of a comprehensive evaluation of the joints and

surrounding soft tissues. A comprehensive evaluation begins by interviewing the subject and reviewing records to obtain an accurate description of current symptoms, functional abilities, occupational and recreational activities and past history. [1]

The wrist complex (radiocarpal and midcarpal joint) permits flexion - extension in the sagittal plane around a medial axis,

and radial and ulnar deviation in the frontal plane around an anterior - posterior. The wrist joint contributes to these ranges of motions in varying amounts. [1]

The amount of motion that is available at a wrist joint is called the range of motion (ROM). The starting position for measuring range of motion, except rotations in the transverse plane, is the anatomical position. Three notation systems have been used to define ranges of motion (ROM). The 0-to 180-degree system, the 180-to 0-degree system of notation is widely used by researchers. It was first described by Silver [2] in 1923; its use has been supported by many authorities.

To determine the normal range of motion (ROM) or angle of the wrist joint via the performance of active joint motion by subject's during the evaluation allows the examiner to screen for abnormal movements and find information about the subject's willingness to move. Various special tests are used in conjunction with Goniometry to help and isolate the injured anatomical structure.

Joint flexibility is the range of motion (ROM) allowed on a joint to move. A range of motion refers to the distance and direction a joint can move to its full potential. The 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. [3]

There is a difference in the range of all movements between the two hands of the same individual.

Evaluating the range and patterns of movement are a key concern for a clinician for the diagnostic and functional assessment of patients joint with musculoskeletal disease. These (ROM) measures are also used to obtain a record of the degree of permanent impairment of an individual joint (Lowery et al. [4] 1992; American Medical Association 1993).

To determine the normal range of motion (ROM) or angle of wrist joint via the performance of active joint motion of the subjects during the examination allows the

examiner to screen for abnormal movements and got information about the subject's willingness to movement of the joint. Resisted isometric muscle contraction and special tests are used in conjunction with Goniometry to help isolate the injured anatomical structure.

MATERIALS AND METHODS

The Present study has been carried out at Smt. B.K.Shah Medical Institute and Research Centre under Sumandeep Vidyapeeth on healthy adult individuals during Aug. 2013- Dec. 2015

The subject aged between 21 to 60 years and with sexual dimorphism (in male & female) where further group divided as follows:-

Group 1 - Age 21 to 30 years.

Group 2 - Age 31 to 40 years.

Group 3 - Age 41 to 50 years.

Group 4 - Age 51 to 60 years.

Each group contains 100 subjects for examination in the present study.

- All the subjects studied had a normal wrist joint skeleton which was included in the present study. Both hands (Right & Left) are used for the study for measurement.
- Subjects having any history of wrist joint surgery, trauma, Rheumatoid arthritis, Gout and any other type of abnormality were excluded from the present study.

Measurements were taken Universal Goniometer. It has a body and two thin extensions called arms a stationary arm, and a moving arm. It can be either a half-circle instrument with 0° to 180° and from 180° to 0° or full circle Goniometer 0° to 360° and from 360° to 0°. In the present study I have been using Goniometer half circle with a reading from 0° to 180°. The stationary arm is often aligned parallel to the longitudinal axis of the proximal segment of the joint and the moving arm is aligned parallel to the distal segment of the joint.



Table/Fig 1:- Universal Goniometer.

1. Flexion:

Motion occurs in the sagittal plane around a medial - lateral axis.

Recommended Testing Position: Position the subject so that he or she is sitting next to supporting surface. The shoulder is abducted to 90° and the elbow is flexed to 90°. The forearm is positioned midway between supination and pronation so that the palm of the hand faces the ground. The forearm rests on the supporting surface, but the hand is free to move. Avoid radial or ulnar deviation of the wrist and flexion of the fingers.

Stabilization: Stabilize the radius and ulna to prevent supination or pronation of the forearm.

2. Extension (Dorsal Flexion):

Recommended Testing Position and Stabilization: The testing position and stabilization are similar to those used for measuring wrist flexion. Avoid extension of the fingers so that tension in the flexor digitorum superficialis and profundus muscles will not restrict the motion.

Normal End - Feel: Usually the end- feel is firmly because of tension on the palmar radiocarpal ligament and the palmar joint capsule, but it may be hard because of contact between the radius and the carpal bones.

Goniometer Alignment: The alignment is the same as for wrist flexion.

3. Radial Deviation (Radial Flexion):

Motion occurs in the frontal plane around an antero-posterior axis.

Recommended Testing Position: The testing position is same as for wrist flexion.

Stabilization: Stabilize the distal ends of the radius and ulna to prevent pronation or supination of the forearm and elbow flexion beyond 90 degrees.

Normal End - Feel: Usually the end feel is hard because of contact between the radial styloid process and the scaphoid, but it may be firm because of tension on the ulnar collateral ligament, ulnocarpal ligament, and ulnar portion of the joint capsule.

Goniometer Alignment:

- a) Center the fulcrum of the Goniometer over the middle of the dorsal aspect of the wrist over the capitate.
- b) Align the proximal arm with the dorsal midline of the forearm, using the lateral epicondyle of the humerus for reference.
- c) Align the distal arm with the dorsal midline of the third metacarpal.

4. Ulnar Deviation (Ulnar Flexion):

Recommend Testing Position and Stabilization: The testing position is the same as for radial deviation of the wrist.

Normal End - Feel: The end -feel is firmly because of tension on the radial collateral ligament and the radial portion of the joint capsule.

Goniometer Alignment: The alignment is the same as for radial deviation of the wrist.

Statistical analysis of the data collected as follows

The mean is obtained by summing up the measurement and dividing the total number of measurements

A series of observation is indicated by the letter X and individual reading by X₁, X₂ X_n

The mean of the series is denoted by the number of observations by n

The sum of observation by Σ n=Number of observation

Formula for calculation of mean is:

$$\text{Mean: } \bar{x} = \frac{\text{Total or sum of the observation}}{\text{number of observation}} \text{ or } \bar{x} = \frac{\Sigma x}{n}$$

RESULT

Table/Fig 2: Comparison between Male (N =200) and Female (N=200).

Motion		Measurements of Movement (MALE) n=200			Measurements of Movement (FEMALE) n=200		
		Range	Mean	SD	Range	Mean	SD
Wrist radial-Deviation	RIGHT	6-27°	16.76°	4.066	8-30°	17.20°	4.21
	LEFT	9-35°	18.94°	4.21	9-35°	19.21°	4.26
Wrist ulnar deviation	RIGHT	13-48°	33.88°	6.31	18-50°	33.90°	6.29
	LEFT	9-50°	35.44°	6.41	19- 50°	36.11°	6.10
Wrist flexion	RIGHT	31-60°	62.64°	7.87	45-90°	64.36°	11.05
	LEFT	53-80°	62.04°	7.25	54-85°	63.72°	9.28
Wrist extension	RIGHT	55-82°	54.64°	7.05	32-63°	50.00°	8.71
	LEFT	30-60°	48.21°	7.20	32-67°	48.16°	9.60

As per table No.02: In our study average range of motion for radial deviation $16.76^{\circ} \pm 4.06$ in male and $17.20^{\circ} \pm 4.21$ in Female in Right hand. And $18.94^{\circ} \pm 4.21$ in Male and $19.21^{\circ} \pm 4.26$ in Female in Left hand. So, Female has a higher range of motion than male in both Right and Left hand.

As per table No.02: In our study average range of motion for Ulnar deviation $33.88^{\circ} \pm 6.31$ in male and $33.90^{\circ} \pm 6.29$ in Female in Right hand. And $35.44^{\circ} \pm 6.41$ in Male and $36.11^{\circ} \pm 6.10$ in Female in Left hand.

As per table No.02 : In our study average range of motion for Wrist Flexion $62.64^{\circ} \pm 7.87$ in male and $64.36^{\circ} \pm 11.05$ in Female in Right hand. And $62.04^{\circ} \pm 7.25$ in Male and $63.72^{\circ} \pm 9.28$ in Female in Left hand.

As per table No.02: In our study average range of motion for Wrist Extension $54.64^{\circ} \pm 7.05$ in male and $50.00^{\circ} \pm 8.71$ in Female in Right hand. And $48.21^{\circ} \pm 7.20$ in Male and $48.16^{\circ} \pm 9.60$ in Female in Left hand.

Table/Fig 3: Effect of Age at Wrist Joint.

Motion		Age group I (21-30 Yrs.) n=100			Age group II (31-40 Yrs.) n=100			Age group III (41-50 Yrs.) n=100			Age group IV (51-60 Yrs.)n=100		
		Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
Wrist radial-deviation	Right	6-25°	17.91	4.33	9-28°	17.06°	3.70	8-30°	16.66°	4.62	10-25°	16.31°	3.71
	Left	10-35°	20.38	4.18	12-35°	19.76°	4.24	9-31°	18.58°	4.73	10-26°	17.59°	3.12
Wrist ulnar deviation	Right	13-50°	34.78	6.86	18-50°	33.82°	6.94	18-48°	33.95°	6.72	26-43°	32.34°	4.67
	Left	24-50°	38.17	5.95	20-50°	36.12°	6.85	19-50°	34.94°	6.90	27-47°	33.88°	4.19
Wrist flexion	Right	45-86°	68.30°	11.0	38-80°	66.36°	10.60	43-80°	65.24°	9.62	54-85°	63.72°	9.28
	Left	40-82°	69.12°	9.60	55-82°	68.64°	7.05	60-80°	68.88°	10.42	53-80°	67.04°	7.25
Wrist extension	Right	42-62°	52.64°	6.54	32-63°	51.86°	8.71	20-65°	50.24°	9.62	32-67°	48.16°	9.60
	Left	40-60°	50.64°	6.23	30-61°	49.24°	7.20	20-62°	50.10°	8.10	32-58°	47.92°	7.32

As per table No.03: In the present study mean range of motion in the age group I (21-30 years) the average ROM is $17.91^{\circ} \pm 4.33$ in Right Hand and $20.38^{\circ} \pm 4.18$ in Left Hand. In age group Group II (31 year to 40 years) the average Range of Motion is $17.06^{\circ} \pm 3.70$ in Right Hand and $19.76^{\circ} \pm 4.24$ in Left Hand. In Group III (41 year to 50 year), the average Range of Motion is 16.66 ± 4.62 in Right Hand and $18.58^{\circ} \pm 4.73$ in Left Hand. In age Group IV (51 year to 60 years), average Range of Motion is $16.31^{\circ} \pm 3.71$ in Right Hand and $17.59^{\circ} \pm 3.12$ in Left Hand.

As per table No.03 : In the present study mean range of motion in the age group I (21-30 years) the average Range of Motion is $34.78^{\circ} \pm 6.86$ in Right Hand and $38.17^{\circ} \pm 5.95$ in Left Hand. In age group Group II (31 year to 40 years) the average Range of Motion is $33.82^{\circ} \pm 6.94$ in Right Hand and $36.12^{\circ} \pm 6.85$ in Left Hand. In Group III (41 year to 50 year), the average Range of Motion is $33.95^{\circ} \pm 6.72$ in Right Hand and $34.94^{\circ} \pm 6.90$ in Left Hand. In age Group IV (51 year to 60 years), average Range of Motion is $32.34^{\circ} \pm 4.67$ in Right Hand and $33.88^{\circ} \pm 4.19$ in Left Hand. r

value of the table no. 2 is $r = -0.106$ in right hand and $r = -0.232$.

As per table No.03 : In the present study mean range of motion in the age group I (21-30 years) the average Range of Motion is $52.64^\circ \pm 6.54$ in Right Hand and $50.64^\circ \pm 6.23$ in Left Hand. In age group Group II (31 year to 40 years) the average Range of Motion is $51.86^\circ \pm 8.71$ in Right Hand and $49.24^\circ \pm 7.20$ in Left Hand. In Group III (41 year to 50 year), the average Range of Motion is $50.24^\circ \pm 9.62$ in Right Hand and $50.10^\circ \pm 8.10$ in Left Hand. In age Group IV (51 year to 60 years), average Range of Motion is $48.16^\circ \pm 9.60$ in Right Hand and $47.92^\circ \pm 7.32$ in Left Hand.

As per table No.03 : In the present study mean range of motion in the age group I (21-30 years) the average Range of Motion is $52.64^\circ \pm 6.54$ in Right Hand and $50.64^\circ \pm 6.23$ in Left Hand. In age group Group II (31 year to 40 years) the average Range of Motion is $51.86^\circ \pm 8.71$ in Right Hand and $49.24^\circ \pm 7.20$ in Left Hand. In Group III (41 year to 50 year), the average Range of Motion is $50.24^\circ \pm 9.62$ in Right Hand and $50.10^\circ \pm 8.10$ in Left Hand. In age Group IV (51 year to 60 years), average Range of Motion is $48.16^\circ \pm 9.60$ in Right Hand and $47.92^\circ \pm 7.32$ in Left Hand.

Table/Fig 4: Comparison between Right and Left Handed At Wrist Joint.

Motion		Measurements of Right handed (n=378)			Measurements of Left handed (n=22)		
		Range	Mean	SD	Range	Mean	SD
Wrist radial- deviation	RIGHT	6-30°	16.78°	4.03	10-30°	20.5°	4.50
	LEFT	9-35°	19.17°	4.26	13-24°	17.5°	3.33
Wrist ulnar deviation	RIGHT	13-50°	33.6°	6.40	24-48°	35.82°	6.20
	LEFT	19-50°	35.95°	6.28	20-40°	32.82°	5.22
Wrist flexion	RIGHT	61-80°	70.86°	11.68	58-80°	68.76°	8.68
	LEFT	43-80°	65.24°	10.82	46-70°	64.24°	5.29
Wrist extension	RIGHT	36-87°	52.24°	5.73	36-67°	52.38°	5.73
	LEFT	42-62°	50.68°	6.54	37-22°	50.72°	6.04

As per Table No.: 04. Average range of Motion of radial deviation $16.78^\circ \pm 4.10$ in Right hand and $19.17^\circ \pm 4.26$ in Left hand in right handed person. Average range of Motion of radial deviation $20.5^\circ \pm 4.50$ in Right hand and $17.05^\circ \pm 3.33$ in Left hand in Left handed person.

As per Table No.: 04. Average range of Motion of Ulnar deviation $33.6^\circ \pm 6.40$ in Right hand and $35.95^\circ \pm 6.28$ in Left hand in right handed person. Average range of Motion of Ulnar deviation $35.82^\circ \pm 6.20$ in Right hand and $32.82^\circ \pm 5.22$ in Left hand in Left handed person.

As per Table No.: 04. Average range of Motion of Wrist flexion $70.86^\circ \pm 11.68$ in Right hand and $65.24^\circ \pm 10.82$ in Left hand in a right handed person. Average range of Motion of Wrist flexion $68.76^\circ \pm 8.68$ in Right hand and $64.24^\circ \pm 5.29$ in Left hand in Left handed person.

As per Table No.: 04. Average range of Motion of Wrist extension $52.24^\circ \pm 5.73$ in Right hand and $50.68^\circ \pm 6.54$ in Left

hand in a right handed person. Average range of Motion of Wrist extension $52.38^\circ \pm 5.73$ in Right hand and $50.72^\circ \pm 6.04$ in Left hand in Left handed person.

DISCUSSION

The Goniometric measurements are done for determining a position and total amount of motion available at Wrist joint.

In a present study 400 volunteer subjects were studied, and they are divided in 4 Age groups. Group I (21 year to 30year), Group II (31 year to 40 years), Group III (41 year to 50year), Group IV (51 year to 60 years), and in each group there are 100 subjects (50 Male + 50 Female).

A lot of care has been exercised over the technique employed in the use of the Goniometer through source of subjective error did exist, but was carefully controlled. Our study was based on the hypothesis that all motion at the wrist is affected by the age, gender and right or left handed.

In age Group I (21 year to 30 years), there were 94 Subject Right handed and 06 subjects Left handed. In age Group II (31 year to 40 years), 94 Subject Right handed and 06 subjects Left handed. In age Group III (41 year to 50 years), 95 Subject Right handed and 05 subjects Left handed. In age Group IV (51 year to 60 years), 95 Subject Right handed and 05 subjects Left handed.

Wrist Radial Deviation

Boone DC and Azen SP [5] (1970) concluded that an American male shows an average Range of Motion of wrist radial deviation $21.4^{\circ} \pm 3.6$ in age group 20-29 years, whereas the age group 30-39 years show an average Range of Motion $20.3^{\circ} \pm 3.1$ and the age group 40-54 years show an average Range of Motion $21.6^{\circ} \pm 5.1$. As compared to our observations in the same age groups of males the values of Boone and Azen are higher.

Gerhardt Von Bonin et al [6]: in their study 11 male and 06 Female, Radial deviation a Male average range of Motion $14.5^{\circ} \pm 0.34$ and in a Female average range of motion $21.7^{\circ} \pm 0.25$. So, female have a higher range of motion than male.

Wrist Ulnar Deviation

P value of table no.04: comparison between right and left hand for radial deviation is <0.005 . So, it is statistically significant

Boone DC and Azen SP [5] (1970) in their study on American males shows an average Range of Motion of ulnar deviation $35.1^{\circ} \pm 3.8$ in age group 20-29 years, whereas the age group 30-39 years shows an average Range of Motion $36.1^{\circ} \pm 2.9$ and the age group 40-54 years shows an average Range of Motion $34.7^{\circ} \pm 4.5$. As compared to our observations in the same age groups of males the values of Boone and Azen are slightly higher.

Green and Wolf [7] (1989) in their study of Rosemont population (10 males and 10 females) found that an average Range of Motion of ulnar deviation is $39.2^{\circ} \pm 2.1$ in age group 18 to 55 years. As compared to our observation in the same age group of males and females the value of Green and Wolf is higher.

Meng-Jung Cung and Mao J et al [8] (2007) in their study conducted on the worker population of Taiwan shows joint Range of Motion decrease with the increase of age, especially wrist joint and female workers showed greater joint Range of Motion than male workers in Taiwan population

Wrist Flexion

Walker et al [9] (1984) in their study in 30 older male and female between 60 and 84 years shows an average ROM $62.0^{\circ} \pm 12.0$.

Chaparo et al [10] (2000) in their study shows an average ROM $50.8^{\circ} \pm 13.8$ in 62 subjects age between 60-90 years.

Wrist Extension

Walker et al [9] (1984) reported an average ROM is $61.0^{\circ} \pm 6.0$ in 30 male and female subjects age group between 60 and 84 years.

Chaparo et al [10] (2000) in their study shows on average ROM $44.0^{\circ} \pm 9.9$ in 62 subject's between age 60-90 years.

CONCLUSION

1. In the present study 400 volunteer subjects were studied and they are divided in 4 Age groups. Group I (21 year to 30 years), Group II (31 year to 40 years), Group III (41 year to 50years), Group IV (51 year to 60 years), and in each group there are 100 subjects (50 Males + 50 Females).
2. Each subject was tested radial, ulnar deviation, Wrist flexion and wrist extension on both hands with the help of Universal Goniometry.
3. In present study average range of motion significantly decreases with increasing age.
4. In my present study average range of motion was significantly higher in female than in male.
5. In my present study average range of motion was significantly greater in the left hand than in the right hand.
6. The range of motion (ROM) was reduced with the increase of age because of the presence of osteoporosis,

cumulative damage and obesity with the aging process.

7. Females tend to have a higher range of motions, due to the anatomical and physiological differences, such as the size of muscle mass, joint geometry and hormone.
8. The reduced mobility on the right side comparison with that on the left might have been the result of slight degenerative changes in the joint as well as damage to the ligaments of the right upper extremity in the right handed population.

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