Scand J Rehab Med 18: 5–7, 1986

REPRODUCIBILITY OF GONIOMETRY OF THE WRIST

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ABSTRACT. The wrist motion in 31 healthy probands was measured by four observers with a simple goniometer under standardized conditions. The INTRA-observer variation was calculated to 5 to 8 degrees and the INTER-observer variation to 6 to 10 degrees. No difference between experienced and non-experienced observers was found. The difference between the right and the left wrist was negligible, indicating that the opposite wrist can be used as reference when evaluating restrictions in motion.

Key words: Biomechanics, wrist, goniometry

Evaluation of the functional end-result after distal radius fractures includes measurement of wrist motion (4, 8, 12).

Investigations into the accurary of goniometric measurements have been applied to various joints (1, 5, 9, 10) but only few descriptions of the range of wrist motion have been given, not including the reproducibility.

The purpose of this study was to examine the INTRA-observer and the INTER-observer variation in all ranges of wrist motion as well as the influence of observer skill and the relationship between contralateral joints.

PATIENTS AND METHODS

The study included 31 right-handed, healthy probands with a median age of 37 (24–65) years. Eight were men and 23 women. Two observers were specialists of orthopedic surgery (A and B), and another two trainees with less than one year's experience of orthopedics (C and D).

The goniometer used was a standard device (Protec AG, Bern).

Each observer examined the probands on three different occasions in sitting position with 90 degrees of elbow flexion. Wrist flexion and extension were measured with the forearm pronated and with alignment of the goniometer arms along the ulna and the 5th metacarpal bone. Ulnar and radial deviation were measured with the goniometer arms parallel to the dorsal aspect of the forearm and the third metacarpal. When measuring forearm rotation one goniometer arm was placed parallel to the upper arm, the other parallel to the plane through the metacarpal bones.

The INTER-observer variation coefficients, estimated from three measurements, were compared by analysis of variance.

To estimate INTER-observer variation the absolute measurements of each motion were subjected to analysis of variance including variation due to observer, proband and arm (right/left).

RESULTS

The standard deviation, when the same observer performed the measurements, ranged from 5.2 degrees to 8.0 degrees (Table I).

The standard deviation when different observers performed the measurements ranged from 6.0 degrees to 10.1 degrees.

In order to elucidate, if the variation was due to difficulties in determining the neutral position the analysis of variance was repeated using the sum of flexion and extension, ulnar and radial deviation and pronation and supination respectively. The standard deviation was not reduced, however.

The measurements of the right and left wrist differed significantly for several of the motions (Table I). The difference, however, was small and not significant, when the total range, i.e. flexion + extension was computed, indicating that the opposite wrist can be used as a reference.

The analysis of the variation coefficients for each observer estimated from three measurements showed that wrist flexion and radial deviation could be determined with the same accurary by all observers (Table II). The other motions differed significantly. None of the observers in this study were especially trained in goniometry, and the measurements of the two orthopedic specialists were not different from those obtained by the other two observers (C and D).

DISCUSSION

Various instruments have been designed for the measurement of joint motion, but have only found application for specific joints, most often the knee

Table I. *Standard deviation (SD) within observers calculated as the result of 3 measurements and between observers (4 testers each performing three measurements)*

Calculation of average range of motion based on 744 measurements in 31 probands

	Same observer SD	Different observer SD	Right/left	Average range of motion (degrees) $\bar{x}$
Flexion	5.2	6.0	1.01 NS	77
Extension	5.8	6.2	0.98*	73
Ulnar dev.	6.4	8.8	1.01NS	40
Radial dev.	5.2	5.4	0.93**	26
Pronation	5.3	6.8	0.98***	86
Supination	8.0	10.1	1.01*	93

NS: $p>0.05$. *$p\leq0.05$. **$p\leq0.01$. ***$p\leq0.001$.

(7). In 1949 Hellebrandt et al. (6) reported on a goniometer recording wrist motion, but the accuracy was found inferior to the universal goniometer. Subsequent reports on wrist motion have used the universal goniometer.

In previous studies of wrist motion (2, 11) the normal range has been demonstrated to show considerable variation, and studies on the reproducibility have only included one of the directions of motion. Low (9) studied wrist extension and found an INTER-observer variation of 10.5 degrees, and in the study by Boone et al. (1), measuring ulnar deviation the INTER-observer and INTRA-observer variation was 4.0 degrees and 3.9 degrees respectively. The results of the present study are in accordance. The standard deviation only increased by a few degrees, when different observers performed the measurements. Changes in wrist motion of less than 10 degrees can thus not be regarded as significant.

Hellebrandt et al. (6), has demonstrated that a well trained physiotherapist could increase the reliability of the measurements. In this study no difference between experienced and non-experienced orthopedic surgeons could be demonstrated, but none of the observers had been especially trained in goniometry.

Values of the normal range of wrist motion has been given by the American Academy of Orthopedic Surgeons (3) and Boone & Azen (2). The average range of motion in this study was of the same magnitude. Boone & Azen (2) also demonstrated an inconsistent difference between the right and left wrist, and attributed this to change. This was confirmed by our results and the opposite wrist can be used as reference when evaluating disability.

Table II. *Variation coefficients SD/$\bar{X}$×100] for each of the four observers*

A and B: orthopedic specialists, C and D: residents

	Variation coefficient (per cent)				
	A	B	C	D	
Flexion	5.7	7.6	5.7	6.4	NS
Extension	6.5	8.6	5.6	7.2	*
Ulnar dev.	15.9	12.3	13.5	18.8	**
Radial dev.	24.3	21.3	19.8	18.0	NS
Pronation	7.5	4.7	5.1	7.6	**
Supination	8.4	7.0	4.5	5.6	***

NS: $p>0.05$. *$p\leq0.05$. **$p\leq0.01$. ***$p\leq0.001$.

ACKNOWLEDGEMENTS

Financial support was received from Statens Lægevidenskabelige Forskningsråd, grant no. 5.52.13.72, and Hafnia-Haand i Haand Foundation, to whom we are indebted.

REFERENCES

1. Boone, D. C., Azen, S. P., Lin, C.-M., Spence, C., Baron, C. & Lee, L. Reliability of goniometric measurements. Physical Therapy *58:* 1355–1360, 1978.
2. Boone, D. C. & Azen, S. P.: Normal range of motion of joints in male subjects. J Bone Joint Surg *61-A:* 756–759, 1979.
3. Committee on medical rating of physical impairment. J Am Med Ass *166:* 20–27, 1958.
4. Frykmann, G.: Fractures of the distal radius including sequelae—shoulder-hand-finger syndrome, disturbancies in the distal radio-ulnar joint and impairment of nerve function. Acta Orthop Scand, Suppl. 108, 1967.
5. Hamilton, G. F. & Lachenbruch, P. A.: Reliability of goniometers in assessing finger joints angle. Physical Therapy *49:* 465–469, 1969.
6. Hellebrandt, F. A., Duvall, E. N. & Moore, M. L.: Reliability of goniometry. The Physical Therapy Review *29:* 302–307, 1949.
7. Jansen, E. & Ørbæk, H.: Reproducibility of gait measurement using the Lamoreux goniometer. Prosthetics and Orthotics Int *4:* 159–161, 1980.
8. Lidström, A.: Fractures of the distal end of the radius. A clinical and statistical study of the end-results. Acta Orthop Scand, Suppl. 41, 1959.
9. Low, J. L.: The reliability of joint measurements. Physiotherapy *62:* 227–229, 1976.
10. Mitchell, W. S., Millar, J. & Sturrock, R. D.: An evaluation of goniometry as an objective parameter for measuring joint motion. Scot Med J *20:* 57–59, 1975.
11. Roaas, A. & Andersson, G. B. J.: Normal range of motion of the hip, knee and ankle joints in male subjects, 30–40 years of age. Acta Orthop Scand *53:* 205–208, 1982.
12. Sarmiento, A., Pradt, G. W., Berry, N. C. & Sinclair, W. S.: Colles fractures, functional bracing in supination. J Bone Joint Surg *57-A:* 311–317, 1975.

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