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Comparison of an Electrogoniometer with the Fisi Metrix Program in the Assessment of Wrist Deviation

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Abstract. [Purpose] The purpose of this study was to compare the measurements of an electrogoniometer with those of the Fisi Metrix program to investigate the reliability and validity of Fisi Metrix assessments of wrist ROM. [Methods] The subjects were eighteen healthy young females. Wrist deviation was measured on images by three raters for measurement of wrist ROM using the Fisi Metrix program. [Results] Radial and ulnar deviation of the wrist between the methods showed a significant correlation, $r > 0.80$, and intra-rater reliability was even higher, ICC(1,1)>0.90. [Conclusion] We consider measurements of ROM by the Fisi Metrix program will be useful in the field of clinical and rehabilitation.
Key words: Electrogoniometer, Fisi Metrix, Range of motion

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INTRODUCTION

Due to the increasing use of computers, extremes in wrist posture and repetitiveness have become risk factors for work-related musculoskeletal disorders[1–3)]. These disorders are a major problem and they not only cause suffering for the individual, but also have high costs for society[4)]. Particularly awkward wrist posture has been identified as a risk factor for disorders of the hand and wrist, such as tendinitis, tenosynovitis and carpal tunnel syndrome[5)]. The measurement of joint movement and range of motion has been used as an important clinical assessment method to evaluate the effectiveness of treatments for joints or their surrounding tissue lesions[6)].

Methods for the assessment of the range of motion (ROM) of joints can vary from joint to joint and also from clinician to clinician[7)], and a variety of methods are in use, including visual estimation, goniometry, inclinometry, flexicurves, wire tracing and tape measures/rulers[8–10)].

However, if such assessments of ROM are to have any meaning, the associated methods of measurement need to be objective, reliable, and valid[7)], even though the experience level of the clinician who measures the position may affect or reduce the reliability[11)]. Therefore, in order to improve the reliability of ROM measurements, it is important for skilled clinical assessment and the recording of position to be performed[12)].

Goniometry and visual assessment of the measurement of ROM are currently the most frequently used methods[7)], and recent literature recommends the use of an electrogoniometer.

An electrogoniometer enables a quick measurement of joint positions and continuous joint motion[13)], but a potential source of error is misalignment of the electrogoniometer with the anatomical axis of the joint, leading to difficulties in determining the zero position, and possible slippages during movement[14)].

Recently, due to these problems, ROM programs such as Fisi Matrix (RS Care system, Korea) have been developed and put into use. This program avoids the above-mentioned problems with equipment, and could be commonly used in clinical practice to perform visual measurement of ROM on images captured by a camera. Fisi Metrix offers the advantage of being able to measure the range of motion using only an image, without any attachments to the joint being measured. Put differently, although it is necessary to attach an electrogoniometer at the anatomical position for an accurate measurement, the attached endblock can be separated from the body, requiring reattachment for measuring other joints, and calibration needs to be done again for the measurement. However, Fisi Metrix makes measurement of ROM possible, thorough an analysis of images captured by camera without any of these attachments. In addition, regardless of the expertise level of the therapist, the measurement tools are easy to operate.

The purpose of this study was to compare an electrogoniometer with the Fisi Metrix program for reliability and validity of assessment of wrist ROM, and to determine the clinical applicability of Fisi Metrix.

SUBJECTS AND METHODS

The subjects were 18 healthy young females with a mean age of 29.3 ±2.5 years, a mean height of 160.0 ±5.6 cm and a mean forearm length of 41.0 ±2.5 cm. All subjects provided their informed consent (Table 1).

In the measurement procedure of this study, an electrogoniometer (Biometrics Ltd, UK) and the Fisi Metrix program (RS Care System, Korea) were used to measure the ROM of wrist radial and ulnar deviation. Both endblocks of the electrogoniometer were firmly secured to the 3rd MPC bone and the longitudinal axis of the forearm with double-sided tape. Calibration was performed in a neutral wrist posture with 90° pronation. Wrist radial/ulnar deviation was carried out in active ROM. The measurement of the range of motion (ROM), after image capture at the beginning and end of the range of motion with a digital camera or digital video camera, requires uploading of images to the Fisi Metrix program, which is a program that can measure the range of motion (ROM) of a joint using a virtual goniometer in the program, similar to using a universal goniometer.

To measure ROM, wrist deviation images were captured after the removal of the electrogoniometer. ROM was measured by 3 raters (a university professor, a graduate student and an undergraduate student) using the Fisi Metrix program. They were trained to use the program and observe ROM measurement with a universal goniometer before participating in the experiment.

All analyses were performed using SPSS for Windows version 12.0. The characteristics of the subjects are expressed as mean ± SD (standard deviation). To examine the inter-rater reliability levels of the electrogoniometer and Fisi Metrix measurement values, Pearson's correlation coefficient was used, and intra-class correlation coefficients (ICCs) were used to examine intra-rater reliability. An alpha level of 0.01 was used as the criterion of statistical significance.

RESULTS

The means and standard deviations of wrist deviation angle are shown in Table 2. For radial deviation, the average electrogoniometer value was 21.11 ±10.88: rater 1, 23.31 ±10.28; rater 2, 24.13 ±9.81; and rater 3, 21.56 ±9.64. For ulnar deviation, the average electrogoniometer value was 12.83 ±5.77: rater 1, 10.75 ± 4.47; rater 2, 11.90 ± 4.76; and rater 3, 11.24 ±4.18.

The radial and ulnar deviations of the wrist between the electrogoniometer and Fisi Matrix showed a significant correlation, r>0.80 (Tables 3 and 4). For ulnar deviation, the average values of the electrogoniometer and the Fisi Metrix program, showed high levels of agreement when referenced to rater 1 (0.88), rater 2 (0.89), and rater 3 (0.91)($p<0.01$). For radial deviation, the average values of the electrogoniometer and the Fisi Metrix program showed high levels of agreement when referenced to rater 1 (0.81), rater 2 (0.89) and rater 3 (0.87)($p<0.01$). The ICCs for the intra-rater reliability of ROM measurement of wrist deviation ranged from 0.94 to 0.97 (Table 5). The Fisi Metrix ROM measurements of the wrist appeared to be highly reliable even though the raters were different.

Table 1. Characteristics of subjects

	Age (yrs)	Height (cm)	Forearm /hand length (cm)
Female (n=18)	29.3 ± 2.5	160.0 ± 5.6	41.0 ± 2.5

Mean ± SD

DISCUSSION

In recent years, due to the development of scientific technology and engineering, a variety of methods for measuring and evaluating the effects of treatment have been introduced. Among these methods, ROM is regarded as an important evaluation method for assessing the effectiveness of treatment and level of disability by therapists and other professionals[12]. However, the reliability of the commonly used goniometer is affected by the complexity of the joint movement, diversity of measurement sites, raters, etc. when measuring ROM[15]. For these reasons, methods for measuring ROM using an electrogoniometer, motion analyses, etc., have been introduced. In order to use these devices, it is necessary to rely on the reliability and validity of the devices as presented by the manufacturers or researchers[12]. The Fisi Metrix program, demonstrated in this study, can also be used to measure ROM through the analysis of body images, but research is necessary to establish its reliability and validity.

The present study investigated the reliability and validity of the measurement of wrist ROM using the Fisi Metrix program through Pearson's correlation coefficient and ICCs, and the results were similar to those of a previous study which compared a universal goniometer with the Fisi Metrix program in wrist flexion/extension[12].

In this study, the correlation coefficient for assessing inter-rater reliability was 0.88–0.99 in the case of ulnar deviation and 0.81–0.96 in the case of radial deviation. In comparison with the study of the reliability of measuring knee joint ROM using an electrogoniometer by Pagamas et al.[13], where the range of inter-rater reliability levels was 0.85–0.88, the reliability of our study is higher. Also in comparison with the 0.62–0.99 reliability levels observed in a study comparing a goniometer and the Fisi Metrix program for wrist flexion and extension by Chae[12], it can be ascertained that the inter-rater differences were small.

In addition, the ICCs of intra-rater reliability in our study ranged from 0.94 to 0.97, and in comparison with the 0.87–0.95 ICC values shown in the study of ROM of the lower limb joints by Kim et al.[16], these values indicate reliability values that are trustworthy. Also, since these values suggest higher reliability than the 0.76–0.98 range reported by Chae[12], it can be stated that the results of our study and those of the previous studies have been confirmed to have no differences.

In other words, in comparing the results of our study and those of the previous studies, both the inter-rater and intra-

Table 2. Means and standard deviations of wrist deviation

Deviation(°)	Electro.	Rater 1	Rater 2	Rater 3
Ulnar	21.11 ± 10.89	23.31 ± 10.28	24.13 ± 9.81	21.56 ± 9.64
Radial	12.83 ± 5.77	10.75 ± 4.47	11.90 ± 4.76	11.24 ± 4.18

Mean ± SD

Table 3. Correlation of wrist ulnar deviation

	Electro.	Rater 1	Rater 2	Rater 3
Electro.	1			
Rater 1	0.88**	1		
Rater 2	0.89**	0.97**	1	
Rater 3	0.91**	0.97**	0.99**	1

$p<0.01$

Table 4. Correlation of wrist radial deviation

	Electro.	Rater 1	Rater 2	Rater 3
Electro.	1			
Rater 1	0.81**	1		
Rater 2	0.89**	0.93**	1	
Rater 3	0.87**	0.93**	0.96**	1

$p<0.01$

Table 5. Intra-rater reliability of wrist deviation

	ICC	95% Confidence Interval
Ulnar dev.	0.97**	0.94–0.99
Radial dev.	0.94**	0.87–0.97

$p<0.01$

rater measurements had high reliability levels; therefore, it can be said that the Fisi Metrix program used in our study to measure the ROM of the wrist, would be useful in the clinical field. In particular, using the Fisi Metrix, the range of motion of the joints can be measured without any physical contact with the subject's body and there is no need for calibration in the starting position. Also, the images used to measure position and ROM can be stored, thereby enabling subsequent visual comparisons of position and angle which would be another advantage of this measurement method.

In addition, the high correlation coefficient among raters showed a small degree of change according to the variable of the rater by image interpretation. Therefore, we consider the measurement of ROM with this program will be useful in the field of clinical rehabilitation.

Finally, there were several limitations to this study. First, it is difficult to measure only the deviation of wrist joint compared to other joints. Second, since the only available comparisons are between an electrogoniometer and the Fisi Metrix program, no comparisons could be made with a goniometer that is generally used in clinical settings; a comparative verification of this is necessary. Finally, because this program measures 2D motion through a movement measurement method for joints using images, it may be difficult to use this program for compound movement of joints in three dimensions, such as those of the shoulder. As such, we think that the investigation of methods that compensate for these shortcomings is warranted.

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