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Reliability of Using Kinovea Program in Measuring Dominant Wrist Joint Range of Motion

[1]Reham M. Abd El-Raheem, [2]Ragia M. Kamel and [3]Mohammad F. Ali
[1]Department of Physical Therapy, Al-Haram Hospital, Giza, Egypt
[2]Departmentof Basic Science, Faculty of Physical Therapy, Cairo University, Giza, Egypt
[3]Department of Orthopedic, Faculty of Physical Therapy, October 6 University, Giza, Egypt

Corresponding Author: Mohammad F. Ali, Department of Physical Therapy, Medical Rehabilitation College, Qassim University, Buraidah, Saudi Arabia

ABSTRACT

The purposes of this study were to investigate the intra-rater and inter-rater reliabilities of the Kinovea software program for the measurement of dominant wrist joint range of motion in healthy participants. One hundred normal subjects with age ranged from 20-35 from both sex. Inter- rater reliability of Kinovea program tested by participation of three different raters and the Intra-rater tested by one rater measured wrist joint ROM three time using digital camera and software device in order to measure the wrist flexion, extension, abduction and adduction range of motion using the Kinovea software program. Results revealed no statistical significant difference in both inter-rater and intra-rater reliability after using Kinovea software in the measurement of wrist joint range of motion. The results of the present study indicated that the Kinovea software program was reliable in both inter and intra-rater reliability for wrist joint ROM measurement.

Key words: Reliability, Kinovea software program, range of motion

INTRODUCTION

Two important biomechanical properties of the intact musculoskeletal system are joint mobility and muscle strength. Joint mobility or Range of Motion (ROM) refers to the angle and direction of joint movement between the flexed position and the extended position (Sengupta *et al*., 2012).

Limited ROM is a relative term indicating that a specific joint or body part cannot move through its normal and full ROM. Shoulder, elbow and wrist joint are considered the functional units of the upper extremity, they work together to promote efficient upper limb function. The most distal joint of the upper limb before the hand, is the wrist joint that allow for the necessary movement for functional activities of daily living. These motions include flexion, extension, ulnar and radial deviation (Hall *et al*., 2007).

Evaluating the range and patterns of movement is a key concern for a clinician in the diagnostic and functional assessment of patients with musculoskeletal disease. Accurate and reliable assessment of the upper extremity is critical for diagnosis and characterization of various neuromuscular conditions and injuries (Guzman-Valdivia *et al*., 2013).

There is a clear need to establish joint specific and movement specific reliability indices for clinical practice, physical therapists should master the objective measurement of range of motion and learn to interpret measurement results correctly. As accurate and reliable

assessment of upper extremity is critical for diagnosis and characterization of various neuromuscular conditions and injuries (Balsalobre-Fernandez *et al*., 2014).

Reliability of ROM measurement tool simply means the consistency or the repeatability of the ROM measurements, the reliability of the measurements expresses their reproducibility or stability only in relation to the time intervals reported. The most accurate evaluation of the reliability of the instrument and procedures is determined when the measurement tests are separated by short time intervals, the classic "test-retest" study design (Gajdosik and Bohannon, 1987).

The ROM measurement tool must deal with the new technology as the kinematic data describes the movement of limbs and is used in biology, sports, orthopaedics and rehabilitation medicine. The data is generally acquired using motion tracking systems, imaging systems or computer simulation, recently new software was developed to measure joints ROM (Hall and Brody, 2006).

Kinovea is a free software application for the analysis, comparison, measurements and evaluation, especially suitable for physical education teachers. Kinovea is able to measure passive and active range of motion; the overview function is a summary image of the video. Little information was available about or, up to our knowledge; the reliability of Kinovea software for the measurement of ROM of the upper limb joints has not been studied before (Attygalle *et al*., 2008).

Furthermore, it can be possible export the data to a spreadsheet with the results of motion analysis. Install the set for video recording, using a webcam, record the movements of the leg, edit the video using Kinovea, place tracking markers on the person's leg, start the analysis, export data to a spreadsheet, find position, velocity and acceleration, with this same data find the inverse kinematics of the leg and then graph the results (Balsalobre-Fernandez *et al*., 2014).

The purposes of this study were to investigate the inter and intra-rater reliability of Kinovea software program for the measurement of dominant wrist joint range of motion in healthy participants.

MATERIALS AND METHODS

Subjects: One hundred normal participants participated in this study, aged from 20-35 years old. Selected from both sexes (55 males and 45 females, 89 right side and 11 left side). They were recruited from the student and the employees of Al-Haram hospital, physical therapy department. subjects were selected according to the following criteria: (a) Aged from 20-35 years old, (b) All subjects were normal and (c) Grade 3 wrist muscles test.

Participants were excluded if they have: (a) History of musculoskeletal or neurological problems of the dominant upper extremity and (b) Any previous upper limb surgery.

Sampling method: Convenient sample of normal subjects from both gender aged from 20-35 years old were selected from Al-Haram hospital, Department of Physical Therapy.

Ethical consideration: Written consent form from the participants was obtained before starting the study.

Instrumentation and tools:

- Digital video camera (CANON A-810 16M 5X HD BK) was located 1.5 m far from the blinth and elevated 1 m from the ground
- Computer equipment for the measurement process

Procedures

Study design: Repeated measurement design was used in this study aiming to assess the intra and inter-rater reliability of the Kinovea software program in normal subjects ranging in age from 20-35 years.

Subjects recruitment: Before recruitment, a health talk was given by the researcher to participants to explain the purposes and methodology of the study. The consent forms were then given to them. After collecting the consent forms, subjects were examined by the researcher for the inclusion and exclusion criteria.

Reliability procedure: This procedure was classified into two main phases:

Preparation phase:

- Put a markers on the bony landmark
  - Markers of flexion, extension wrist (Lateral placement over the triquetrum, tip of 5th metacarpal, the lateral epicondyle)
  - Markers of ulnar, radial deviation (Dorsal capitates, dorsal midline of the forearm, the third metacarpal)
- The participant did the active full ROM three times prior to the assessment in order to learn the movement
- Each subject instructed to:
  - Avoid forceful contraction
  - Maintain the starting position before instructed to move
- The subject was ready to move by take the starting position (sitting with elbow 90° flexed, the wrist out of the chair for flexion and extension and rested on the arm chair in ulnar, radial deviation)
- The subject moves the wrist in flexion, extension, ulnar and radial deviation until reach the full range of motion
- Take the capture using the digital camera

Analysis phase

Inter-rater reliability:

- Three raters A to C qualified physiotherapists (Rater A physical therapist specialist with 20 year experience, rater B physical therapist specialist with 11 year experience and rater C physical therapist with 8 years experience were participated were briefed on the study protocol and the raters practiced the measurement procedure before the experiment to ensure testing reliability, familiarization and standardization of the analysis of the wrist joint ROM on the Kinovea program
- Three raters analyzed the four movements of wrist joint range of motion for all subjects on Kinovea tracking system software by the same preparation procedure
- All raters were blinded to the results of each other's assessment

Intra-rater reliability:

- Only rater B was used for the intra-rater reliability trial. This rater tested all subjects on three separate occasions with a 48 h period separated
- Each time, the previous analysis data covered to prevent bias

Statistical analysis: Data analysis was performed with SPSS version 20.0 for Windows. Descriptive data including mean measurement of wrist joint angles with Standard Deviations (SD) was calculated for each session and for each rater. The Intraclass Correlation Coefficient (ICC) was used to provide an estimate of agreement both within and between raters.

RESULTS

Participants' Mean±SD age was 26.46±7.18 years, height was 165.93±8.95 cm, weight was 65.26±8.43 kg and body mass index was 23.59±0.8 kg m^{-2}.

The intra-rater and inter-rater reliabilities of measurements made with Kinovea were verified with ICC values for wrist measurements. For the determination of intra-rater reliability, the values were 0.987 for wrist flexion, 0.979 for wrist extension, 0.978 for ulnar deviation and 0.926 for radial deviation, as shown in Table 1. Regarding the inter-rater reliability, the values were 0.979 for wrist flexion, 0.949 for wrist extension, 0.954 for ulnar deviation and 0.877 for radial deviation, as shown in Table 2.

DISCUSSION

The purposes of this study were to investigate the inter and intra-rater reliability of Kinovea software program for the measurement of dominant wrist joint range of motion in healthy participants.

In this study, inter and intra-rater reliability of Kinovea software program were evaluated for each subject by measurement of wrist joint ROM. The ICC of the intra-rater measurement in wrist flexion was 0.987, in wrist extension 0.979, in wrist ulnar deviation 0.978 and in radial deviation 0.926. The inter-rater reliability was 0.979 in wrist flexion, 0.949 in wrist extension, 0.954 in wrist ulnar deviation and 0.877 in wrist radial deviation.

Results revealed no statistical significant difference in both inter-rater and intra-rater reliability after using Kinovea software in the measurement of wrist joint range of motion. Therefore, we accepted the null hypothesis that there was there was no statistical significant

Table 1: Intra-reliability of Kinovea for measurement of wrist movements

Joint movement	1st	2nd	3rd	ICC	95 CI (%)
Flexion	99.77±7.53	99.86±7.61	99.89±7.58	0.987	0.981-0.991
Extension	111.06±5.75	111.24±5.70	111.33±5.78	0.979	0.970-0.985
Ulnar deviation	36.24±5.46	36.49±5.55	36.55±5.42	0.978	0.969-0.984
Radial deviation	19.77±2.53	19.90±2.71	19.86±2.67	0.926	0.899-0.948

Intra-rater measurement Mean±SD, ICC: Intraclass correlation coefficient, CI: Confidence interval

Table 2: Intra-reliability of Kinovea for measurement of wrist movements

Joint movement	Rater 1	Rater 2	Rater 3	ICC	95 CI (%)
Flexion	99.09±7.70	99.30±7.56	99.26±7.66	0.979	0.970-0.0985
Extension	111.82±5.42	111.90±5.56	112.51±5.62	0.949	0.929-0.9640
Ulnar Deviation	36.73±5.72	37.06±5.86	37.51±7.80	0.954	0.933-0.0968
Radial Deviation	19.17±2.64	19.35±2.67	19.43±2.66	0.877	0.833-0.9110

Intra-rater measurement Mean±SD, ICC: Intraclass correlation coefficient, CI: Confidence interval

difference in inter-rater reliability after using Kinovea software in the measurement of wrist joint ROM. We also accepted the null hypothesis that there was no statistical significant difference in intra-rater reliability after using Kinovea software in the measurement of wrist joint ROM.

There were many measurement tools used in physical therapy field for ROM measurement, beginning with universal goniometer ending with 4D motion analysis device. Their reliability, validity was well established and widely accepted. However, the therapist faced many problems during the measurement procedure, firstly with the universal goniometer: keeps the reference arm of the goniometer stationary while rotating the joint seem to be difficult. It also may be difficult to read the goniometer at end ROM, removing the goniometer from the joint to read the value can result in unintended movement of the goniometer. The digital goniometer also had the same disadvantages of the universal goniometer plus it was heavy weight. The most disadvantages of the electro goniometer that, the therapist need to have one electro goniometer for each joint in the body and that will need specific design and finical support for every one of them. The other measurement tools reached to the 4D motion analysis device require specific laboratory which was not valid all the time and those devices were expensive, so the physical therapist in need to have a new, low cost, easily applicable, light weight, valid all the time, match with the new technology and accurate method for measuring the body ROM, the ideal measuring system is one that can be easy to use without the need to utilize sensors attached to the body and cheap (Faro, 2009).

Because little literature is available on the Kinovea, we felt that a study exploring the validity and reliability of this software program was necessary. For a measurement instrument to be useful, the two most important factors. reliability and validity which affecting objective measurements must be established. As, the physical therapists should master the objective measurement of range of motion and learn to interpret measurement results correctly. By doing so, the potential contribution to Kinovea for the development of a scientific basis of physical therapy will be enhanced (Mullaney, 2010).

Choosing of Kinovea software program in measurement the joint ROM come in agreement with (Schaun *et al*., 2013) using the open-source software (Kinovea 0.8.15) as instrument for measurement the lower limb power and performance in a sport-specific test in female volleyball players for a state level competition. Intra-observer reliability is concerned, a highly three experienced coach analyze. For inter-observer reliability one coach was analyze of three times, with 3 days between each viewing. It demonstrates highly intraclass correlation coefficients.

It also comes in agreement with Balsalobre-Fernandez *et al*. (2014), how measure the flight time that consider the most accurate and frequently used variable when assessing the height of vertical jumps. Two observers with no experience in video analysis analyzed the 125 videos independently using the open-license Kinovea 0.8.15 software. The results showed a perfect correlation agreement between both observers' measurements of flight time and jump height and a highly reliable agreement between the observers' measurements of flight time and jump height using the HSC-Kinovea method. It also demonstrate that Kinovea is accurate when comparing with IR system platform.

Salmon and Wright (2014) and De la Vega *et al*. (2007) reported the use of the open-source technology to teach and learn biomechanics it is a real way to learn the physical principles applied to biomechanics and human movement studies. With this different lecture approach the students filmed the target movements, analyzed the variables selected, collected the data and they draw the conclusions from their hands-on experience always with the affordable equipment's (cameras, laptops...) and free software (Kinovea, tracker ...).

Faro and Pedro (2014) establish the validity and reliability of 3 softwares, one of them was the Kinovea program. Abbas and Abdulhassan (2013) analyzed the data of hip, knee and ankle kinematics in sagittal plane during stair ascent and descent using kinovea and origin pro.8.5 softwares as a reliable method.

Boone *et al*. (1978) reported that the interested reliability was higher for upper extremity motions than for lower extremity motions. These results suggest that reliability of measuring ROM is specific to the action measured and to regional structure and function. These results suggest that reliability of measuring ROM is specific to the action measured and to regional structure and function. For example, measurements of the elbow, generally considered a simple hinge joint, show less day-to-day variation in ROM than measurements of the wrist.

Cleland *et al*. (2006), Glasgow *et al*. (2003), Ogince *et al*. (2007) and Van der Wurff *et al*. (2000) reported that the measurement of small joints with greater range such as the finger joints has been shown to be reliable. Van de Pol *et al*. (2010) also found that measuring large physiological ranges of motion, like that in the shoulder and in the wrist, frequently yielded satisfactory levels of reliability.

A number of studies have concluded that normal ROM may vary with both age and sex. Decreased ROM is often accepted as a normal pan of aging. James and Parker (1989) examined age-associated decline in joint mobility, comparing the two oldest age groups with the two youngest age groups, found decreased joint mobility for all hip and knee motions. The small size of the differences in mean ROM between the youngest and oldest age groups was somewhat surprising, given the commonly held belief that aging produces a substantial decline in ROM.

The assessment of validity and reliability of a new ROM measurement tools is so important, as the existing tools have many disadvantages beginning from the size, price, availability ending with the reliability and the ability of physiotherapist to deal with it, so Kinovea software program is become valid and reliable measurement tool that can be used in the physical therapy field.

CONCLUSION

From the obtained results of the present study, it can be concluded that the Kinovea tracking system is highly reliable in both inter and intra-rater assessment of the wrist joint ROM.

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