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RESEARCH ARTICLE

VALIDATION OF A SOFTWARE ANALYSIS IN MEASURING SHOULDER'S RANGE OF MOTION IN HEMIPLEGIC PATIENTS WITH ADHESIVE CAPSULITIS

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ABSTRACT

Objectives: Assessment of range of motion (ROM) in Physical therapy field is essential for both normal and abnormal subjects, with modern innovations in technology. The physical therapist becomes in need to use available, cheap, quick and easily applicable software for measuring joint angle ROM. This study was conducted to investigate the validity of Kinovea software for measuring shoulders joint ROM in patients with Hemiplegia. **Methods:** Shoulder joint (flexion, abduction, and external rotation) ROM was measured in thirty patients with Hemiplegia from both genders, their ages ranged from 50 to 65 years. The digital goniometer & Kinovea software analysis was used to measure shoulder ROM. The measurement was one time from supine position for every subject. **Results**: A Pearson correlation was run to determine relation between Kinovea software and digital goniometer to measure shoulder flexion, abduction and external rotation with P- value (0.001, 0.001 and 0.002 respectively). **Conclusion**: This study showed a high validity of kinovea software in measuring shoulder joint ROM in patients with Hemiplegia.

INTRODUCTION

Adhesive capsulitis of the shoulder (AC), also known as "frozen shoulder," is a common shoulder disorder in patients with hemiplegia. Proper shoulder function is need for produce appropriate hand function as proximal stability was needed to produce distal mobility, just as for playing out various assignments including portability, ambulation, and exercises of daily living (ADL). A typical issue of stroke is hemiplegic frozen shoulder, which can hamper practical recovery and in this manner lead to disabilities. Hemiplegic shoulder pain can start around two to three months post-stroke, and its prevalence is 29% of patients with ischemic stroke[1]. Examination of AC was dependent on history and physical assessment, when shoulder range of motion (ROM) is restricted in every direction without structural injury.

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Accordingly, the measurement of the shoulder ROM is significant for the finding of AC just as the subsequent assessment. ROM is normally measured with a goniometer; the ordinary goniometric measures can produce inappropriate analysis and require long duration and more efforts were needed [2]. After the stroke, 80% of patients experience acute paresis of the upper extremity and only approximately one third achieve full functional recovery. Predicting functional recovery for these patients is highly important to provide focused, cost-effective rehabilitation. Ranges of motion (ROM) measurements are essential for the evaluation and diagnosis of shoulder AC. In spite of that, taking these measurements utilizing a goniometer is improper to allow accurate results, while Microsoft is picking up consideration as another method to recognizing movements that is more accurate and simple [3]. Goniometers are easy to apply, low in cost, and do not require data reduction[4].One major drawback of these traditional ROM assessment methods is that the appropriate application depends on the examining clinician who has the potential for error, especially when dealing with the complexities of the shoulder joint[5] . The reference arm of the goniometer should be fixed by the clinician's hand while

the goniometer's other arm rotates with the movement of the measured joint. This is not easy in some situations, such as a shoulder internal rotation (IR) and external rotation (ER) at 90° of abduction in which the reference arm does not refer to a bony landmark [6]. Kinovea is free software used for the analysis, comparison, and evaluation of sports and training. It is also suitable for physical education teachers and coaches. This software has many advantages; it is easy to use and does not require physical sensors during the analysis[7]. Also, the software can be used as a measurement tool for motion analysis. An ideal measuring system is one that is inexpensive and can be used easily without the need for sensors attached to the body[8].

Kinovea was used in previous studies to measure the kicking actions of Taekwondo athletes**,** to measure the position, velocity, and acceleration of the lower limbs in healthy participants and to measure the foot strike angles of novice runners[9]. Recently, also the validity and reliability of the Kinovea software were studied for measuring the flight time and height of vertical jumping of runner [10], for measuring the reliability of Kinovea software in measuring shoulder range of motion in normal subject [19,] However, no studies up to date have been evaluated the validity of Kinovea software for measuring shoulders joint ROM in patients with hemiplegia, therefore, this study was the first one which aimed to investigate the validity of Kinovea software in measuring shoulder flexion, abduction, and external rotation ranges in patients with hemiplegia.

MATERIALS AND METHODS

Study design: A cross-sectional observational study was used to determine the validity of Kinovea software. Active ROM of three shoulder joint movements was evaluated using the Kinovea software. Shoulder flexion, abduction, and external rotation were evaluated in patients with hemiplegia in a supine position.

Participants: Selection and description of participants: Thirty patients (18male and 12 female) with hemiplegia caused by ischaemic stroke (a blood clot blocks the flow of blood and oxygen to the brain) were selected for the study. All patients were selected from the outpatient clinic of the Faculty of Physical Therapy, Modern University for Technology and Information in the period from June 2019 to October 2019. This study was conducted in Modern University for Technology and Information, Cairo, Egypt. The main inclusion criteria included: All patients have ischemic stroke from one year to two years with mild spasticity (Grade 1 and 1+ Modified Ashworth scale) and shoulder AC confirmed by drop arm test. The participants were excluded if they had Diabetes mellitus confirmed by Hemoglobin A1c, Rotator cuff injury, supraspinatus tendinitis, impingement syndrome confirmed by Neer test, Cervical spondylitis, cervical spondylosis confirmed by Compression test of cervical, and any other causes of shoulder pain and weakness other than AC.

Randomization: All participants read and signed a consent form before the beginning of the study, the anonymity and confidentiality were assured and all the procedures were performed in compliance with relevant laws and institutional guidelines. Patients were randomly assigned into two groups; randomization was carried out by asking the patient to draw a folded paper that was labeled with the tested movement from a box with the use of a computer-based randomization program. No dropping out of participants from the study was reported after randomization (Figure 1).

Ethical approval for the study: The study was ethically approved by the Institutional Ethical Committee of the Faculty of Physical Therapy, Cairo University, Egypt (No: P.T.REC/012/002664). All patients read and signed two copies of a consent form before the beginning of data collection.

Sample size: Overall, thirty participants satisfying the inclusion conditions were involved in the study, using G*POWER statistical software, a sample size calculation was done (version 3.1.9.2; Franz Faul, Universitat Kiel, Germany [11]) and discovered that the suitable sample size was n=30.

Interventions

Study group: All patients were asked to wear light clothing to allow for better identification of the bony landmarks and to avoid motion restrictions. Before recording any measurement, the tested movements were practiced three times to familiarize the participants with the procedure and the motions being measured. Before beginning the measurement of the motion, a pen marker was used to draw cross marks on preselected anatomical landmarks on the tested affected upper limb (acromion process, coracoid, olecranon process, and the lateral epicondyle, mid-thoracic line, and mid-shaft of the humerus) Using these marks, we quantified the following three movements that each participant performed at a maximum active (end-range) joint movement at each patient own pace (Figure 2).

Outcomes measures

Kinovea software: applied using one digital camera (Nikon Coolpix S3200, effective pixels 16 MB; Nikon Corp., Tokyo, Japan) to capture the sagittal and the frontal plane profile of the affected shoulder to capture Images for each patient. The camera was placed 1.5 m away from the patient on a tripod at a height of 80 cm. To maintain the same distance between the camera and the patients; the tripod was placed on taped markers on the floor. Then asking the patients to apply the motion actively as much as he can and we capture the photo.

All images were imported into a laptop and analyzed using Kinovea software, which is free, open-source software created for movement analysis (version 0.8.15, http://www.kinovea.org/).After take the capture. Export the image to Kinovea software downloaded on the lab top, the analysis beginning by choose the image need to analysis, then select the angle key image tool from the toolbar on the software, this key image is a shape like angle have a center point and two arms . Put the center point of the angle key image tool on the fulcrum detected before using the pen marker then drag the other two points of the arms to form a shape of angle.

The angle measured as follow: Shoulder Flexion-AROM: To measure the shoulder flexion angle, a line was drawn from the fulcrum point at acromion process to bisecting the mid-thorax line (stationary arm). Another line was drawn to bisecting the point demarking the mid-shaft of the humerus (movable arm). The angle of the intersection of the two lines was measured in degrees (Figure 3).

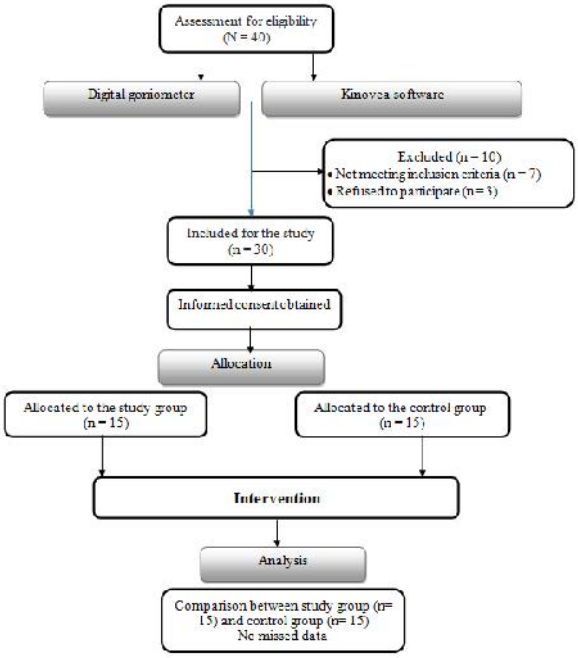

Figure 1. Flow chart showing the experimental design of the study

Figure 2. Anatomical landmarks

Figure 3. The angle of the intersection of the two lines of shoulder flexion

Shoulder Abduction-AROM: To measure the shoulder abduction angle, a line was drawn from the fulcrum point to bisecting the point of the mid-thorax line (stationary arm), and another line was bisected the point demarking the shaft of the humerus (movable arm). The angle of the intersection of the two lines was measured in degrees (Figure 4).

Figure (4): The angle of the intersection of the two lines of shoulder abduction

Shoulder External rotation-AROM: The External rotation angle was formed by a line drawn from the fulcrum point through the shaft of the ulna (movable arm) and a line perpendicular to the plinth (stationary arm) [12] as (Figure 5).

Figure (5): The angle of the intersection of the two lines of shoulder external rotation

Digital goniometer: with Enormous clear LCD controlled by one 9V battery, the arms have 2 tempered steel rules with 7" and 4" sharp edges.

Control group: Using the digital goniometer calibrated to zero prior to each patient being measured, measuring the shoulder ROM (flexion, abduction and external rotation) the same before.

Statistical analysis: All statistical calculations were carried out using the computer program IBM SPSS version 22 (IBM Corporation, USA). The sample size calculation was performed using the G*Power software (version 3.0.10). The test of homogeneity (Leven's test) showed that all data were homogenous. Test of normality (Shapiro-Wilk test) showed that data concerning ROM were normally distributed, so Pearson correlation was performed between shoulder ROM using Kinovea Software and Digital goniometer. The P-values of less than 0.05 were considered statistically significant.

RESULTS

The demographic baseline data of patients: The age of patients in both the control and study groups were statistical insignificant (mean ± SD was 56.2±4.2 years), the height (mean ± SD was 167.8 ± 8.3 cm), and the weight (mean ± SD was 78.9 ± 7.2 kg).

Table 1. Describtive statistics of ROM measurment using both Genoimeter and Kinovea softwear

	Flexion		*Abduction*		*External rotation*	
	Gon	Kino	Gon	Kino	Gon	Kino
Minimum	152	154	60	61	52	56
Maximum	165	164	80	78	65	69
Mean	157.89	159.56	72.33	69.89	58.11	62.56
SD	4.512	3.909	7.416	6.972	4.197	4.825
Correlation R-value	0.911**		0.910**		0.867**	
P-value	0.001		0.001		0.002	

Gon.: Goniometer; Kino: Kinovea Software.**Correlation is significant at the 0.01 level.

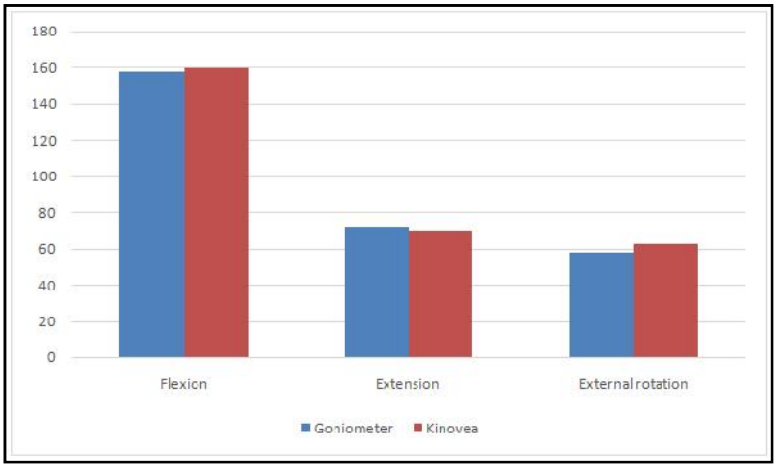

Figure 6. Comparison between mean values of shoulder flexion, extension and external rotation range of motion, measured using digital goniometer and Kinovea software

The correlation between Kinovea software and digital goniometer to measure shoulder ROM in patients with hemiplegia: The validity of Kinovea software for measuring shoulder joint ROM was measured by comparing shoulder joint ROM that measured by Digital goniometer in thirty patients with Hemiplegia. A Pearson correlation was run to determine relation between Kinovea software and digital goniometer to measure shoulder flexion, abduction and external rotation (Table 1) showed the correlation analysis between Shoulder flexion, abduction, and external rotations ROM were measured with Kinovea software in comparison to ROM measured by digital goniometer using Pearson Correlation. The statistical test revealed that there was strong positive correlation between ROM measurements using both methods of assessment for flexion (r-value= 0.911), abduction (r-value = 0.910), and external rotation (r-value = 0.867) with p-value < 0.01. Moreover, (Table 1) and (Figure 6) showed mean, SD, shoulder ROM measurement using both methods.

DISCUSSION

Our study showed that, the Validity of Kinovea software to measure shoulder flexion, abduction and external rotation with P- value (0.001, 0.001 and 0.002 respectively) in patients with hemiplegia. This is agreement with Richardson,[13] that Picking of Kinovea Software program in measuring the joint ROM to evaluate various angles for each joint and follow up after some time, to determine any changes occur in joints over times, which is basic to comprehend practical recovery after stroke and to point treatment and prevention for further complications. Physical assessment is presently the most used clinical apparatus for appraisal of paresis, joint movement and optional biomechanical changes. Balsalobre et al.,[14] discovered that Kinovea Software program has many advantages as the measurements taken were an objective method as well as a quantitative technique, it is accurate, it was need a minimal effort, and subjects don't have to wear or contact anything and therapist don't have to hold or adjust anything. Van der et al., [15]Suggested that Kinovea Software program helpful to assess the pattern of motion for patients with musculoskeletal and neuromuscular disorders. It is accurate and reliable evaluation of the upper limb passive and active range of motion in post-stroke patients. Choosing of Kinovea software program in measurement the joint ROM comes in agreement with Bonnechère et al.,[16]who measure the active range of motion (AROM) of upper extremity function in people with hemiparesis less than one-month post-stroke to detect prognosis for each case. Conceptually, AROM against gravity in people post-stroke can be considered a quick measure of the capacity of the spared motor system to activate the spinal motoneuron pools. AROM values are predictive of later upper extremity function and predictive value for the prognosis. The ROM measurement was kinematic information about the movement of limbs and is utilized in rehabilitation. The information was commonly gained utilizing joint ROM and analyzes it by software program. Kinovea is a free program application for the examination, correlation, and measurement ROM. Kinovea can measure the passive and active range of motion; the outline work is a rundown picture of the video[17.] Moreover, Renée et al.,[18] use photography to follow up the patient's condition at the outpatient clinic and in the home. This enables the specialist to save the photograph or motion picture and exhibit the change (e.g., before and after intervention or prognosis) by demonstrating consecutive photographs or films to the patient. This gives the chance to build understanding commitment and adherence to restoration treatment. Moreover, between treatment sessions and for the long haul follow-up the patient needs to visit the facility less as often as possible without losing significant data on the patients' advancement.

In addition, Reham et al.,[19] found several advantages of Kinovea software for measure shoulder ROM over other used methods, including visual estimation, classic double-armed goniometer, digital inclinometry, and high-speed cinematography. The free, open-access software is widely available to users, giving it a distinct advantage over other digital inclinometers and more complex measurement tools

Conclusion

The Validity of Kinovea software for the measurement of ROM of the upper limb joints has not been studied before in patients with hemiplegia. So, this study conducted to determine the correlation between Kinovea software and digital goniometer to measure shoulder flexion, abduction and external rotation. The results showed that Kinovea software has high validity to measure shoulder joint ROM in patients with Hemiplegia.

Recommendation

We recommended comparing kinovea software with different range of motion measurements tools on different neurological and orthopedic cases, in order to test its validity.

Conflict of interest: None

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