ORIGINAL ARTICLE

Is the Digital Goniometer a valid assessment tool for positioning sense in male individuals with primary knee osteoarthritis?

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ABSTRACT

Aim: To examine the validity of digital goniometer in measuring knee proprioception in individuals with primary knee osteoarthritis.

Methods: Thirty male individuals diagnosed with primary knee osteoarthritis participated in this study (their mean age was 48.4±6.81; weight was 71.95±15.05; height was 165.33±9.35 &BMI was 26.16±4.25). Medical history, physical examination and Lower Extremity Function Scale , Numeric Pain Score and Kujula scale were taken to determine knee joint function and pain levels. All individuals underwent active repositioning test using digital goniometer to determine absolute angular error for 30 and 45 degrees of knee flexion.

Results: There was a weak positive non-significant correlation between absolute angular error measurement at 30° with numeric pain score (p=0.62), lower extremity function scale (p=0.58), and Kujula (p=0.69). There was weak positive non-significant correlation between absolute angular error measurement at 45° with numeric pain score (p=0.62), There was a weak positive non-significant correlation between absolute angular error measurement at 45° with Kujula (p=0.84) while there was a weak negative non-significant correlation between absolute angular error at 45° and lower extremity function scale (p=0.93). Intra-rater reliability of absolute angular error measurement suggested moderate reliability for 30° (ICC:0.71) and good reliability for 45° (ICC:0.76).

Conclusion: Digital goniometer was not a valid tool in measuring knee proprioception (active repositioning test) in individuals with primary knee osteoarthritis.

Keywords: Knee osteoarthritis, knee proprioception, digital goniometer, lower extremity function scale and Kujula scale.

INTRODUCTION

The proprioceptive inputs conveyed from various sensory systems direct neuromuscular performance. It develops instant joint protection and enhances postural control reactions against involuntary postural changes[1]**.** Therefore, it is crucial for the performance of walking; and daily and sport activities[2].

Improved proprioception minimizes injury in hypermobile knee, anterior cruciate ligament injury, and osteoarthritic knee[3]**.** Knee osteoarthritis (KOA) particularly in the older population limits both daily activitiesand knee proprioceptive accuracy[4,5]**.** Prevention and treatment of the OA with proprioceptive rehabilitation may be a trend if a proprioceptive deficit is found in those individuals[6]**.**

Studying the relationship between proprioceptive deficiency and the development of KOA is crucial. Since proprioceptive deficiency initiates the injury, the studying of causative factors, preventive measures, and rehabilitation strategies are important for monitoring bothjoint diseases and sport injuries **[7, 8].** Eleven studies speculated a marked impairment in either position **[9, 10]** or motion senses **[11, 12].** There is evidence that knee OA patients with severe radiological osteoarthritis (ROA) have more proprioceptive deficits than patients with minimal symptoms. Two studies concerningposition senserevealed a significant difference between Kellgren/Lawrence grades 1,3 and between grades 2,4[13]**.**

Isokinetic testing costs a lot and necessitates repeating tests and setting up **[14].** Some obstacles interferewith conducting a proper testing process such as the altered sensory feedbacks resulted from limb stabilizers and the assessment of Joint position sense (JPS) in a closed chainposition[15]**.** On the contrary, the digital goniometer is convenient and easily applied in the outpatient clinic. Previous literature supported the use of position sense to assess proprioceptive accuracy[14,16] and the degenerated articular surfaces alter mechanoreceptive input[17,18]**.** The main objective of this study was to evaluate the validity of knee proprioception using the digital goniometer and its intra-rater reliability for the clinical field.

MATERIALS AND METHODS

Subjects: The study conducted after having the local ethical committee approval No: P.T.REC/012/002960 (Faculty of physical therapy, Cairo University). Inclusion criteria involved thirty patients their ages ranged from 40 to 65 years old participants who had no lower extremity injury history, and diagnosed as primary knee OA. Medical history, physical examination and Lower Extremity Function Scale (LEFS), Kujula scale, and Numeric Pain Score (NPS) taken to determine knee joint function and pain levels. While exclusion criteria included history of lower extremity surgery, knee ligamentous lesion, meniscus pathology, lower extremity fracture history.The testing method was the active joint position testing[19, 20]**.** The JPS testing conducted in the sitting position without feet floor contact, at a quiet place with closed eyes, then assessing the affected extremities of all participants. All the participants filled in the LEFS questionnaire and Kujula as a measure for self-reported overall physical functioning in individuals with hip or knee OA[21]. Also all of the participants score their average pain intensity in last the 24 hours (current,best, or worst) using NPS.

Instrumentation: All individuals signed a consent form prior to the participation in the study, then demographic data recorded. Patients instructed to avoid aggressive exercise before commencing the procedure. The first author conducted the concerned measurements. Determination of the dominant leg executed through asking this question: "Which leg would you prefer to kick a ball?". The Active JPS assessment conducted in an isolated room away from any visual or auditory stimulation[4, 22].

The active joint position sense testing measured using a digital goniometer sensitive for 0.1° (Lafayette, IN, USA).Subjects were instructed to wear head phones and dark glasses to minimize the auditory and visual cues from the testing apparatus; then wore short bands to decrease any external skin sensation from clothing touching the knee area. A digital goniometer fixed to the lateral side of the knee with adhesive tape with fixed arm pointing towards greater trochanter of femur, and the movable arm pointing to lateral malleolus and fulcrum at the joint line (Figure 1). One trial allowed at each angle before testing. The subject then asked to move the knee joint to a pre-determined target angle of 30°and 45°.

Authors chose 30° as the proprioception target angle because it was within the angular interval between 20° and 40° that showed a strong correlation with normal cadence and demonstrated to be more accurate regarding functional measurement[23] (Figure 2).Target angles (30-45) was in the middle (from 40° to 80° flexion) of the knee joint's range of motion to perform a more reliable evaluation. As the detection of the JPS at near terminal extension degrees are quite difficult and incorrect, rather than wider angles[24] (Figure 3).

Authors used 90° flexion as a starting position for isokinetic procedure[25,26]. Individuals extended knees from the starting position (90° knee flexion) until reaching 30° and 45°. The authors demonstrated the 30° and 45° target angles three times, then asked individuals to reproduce this angle three times and recorded the angles.

Participants sat upright in an adjusted chair with the back supported and the hip at an angle of 80° of flexion in a comfortable position, blindfolded, dangling legs over the side of the table. Subjects avoided cutaneous stimulation through the use of a small rubber pillow (2 cm thick) placed under the thigh. The knee joint and the distal part of the hamstrings were far away from the chair[4,22]. A digital goniometer with a precision of 0.1° (Lafayatte Instrument, USA) then attached to the lateral knee aspect.

Individuals actively moved the limb to the target angles and, upon satisfaction with the angle, they told to hold for about 10 second. The degrees deviating from the reference angle then recorded without regard to the direction of error (the Absolute Error (AE)). The average of the three successive measurements calculated to be the Absolute Mean (AM) which used for statistical analysis. Three efforts performed with 10 seconds rest periods between each test.

Statistical analysis: Descriptive statistics carried out for subject characteristics. Person Product Moment Correlation Coefficient conducted to determine the correlation between variables to test the face validity. ICCs with 95% confidence intervals were conducted for analysis of intra rater reliability. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

RESULTS

Subject characteristics: Thirty male individuals diagnosed with primary knee OA participated in this study. Subjects' characteristics presented in (Table 1).

Validity: The correlations between AAE measurement at 30° with NPS, LEFS and Kujula were weak positive non significant correlation ($p > 0.05$) (Table 2).

The correlations between AAE measurement at 45° with NPS and Kujula were weak positive non significant correlation ($p > 0.05$), while was weak negative non significant correlation with LEFS (>0.05) (Table 3).

Reliability: Intra-rater reliability of AAE measurement suggested moderate reliability for 30° (ICC: 0.71) and good reliability for 45° (ICC: 0.76). (Table 4)

Table 1: Subjects' characteristics.

	Segment translation (cm)	r value	p value
30°	NPS	0.09	0.62
	LEFS	0.1	0.58
	Kujula	0.07	0.69

r value: Correlation coefficient value - p value: Probability value

Table 2: Correlation between AAE measurement at 30° and NPS, LEFS and Kujula

	$\bar{X}$ ±SD	Min.	Max.	Range
Age (years)	48.4±6.81	41	63	20
Weight (kg)	71.95±15.05	45	104	59
Height (cm)	165.33±9.35	144	180	36
BMI (kg/m²)	26.16±4.25	17.58	35.88	18.31
Affected side, RT/LT	16/14			

Table 3: Correlation between AAE measurement at 45° and NPS, LEFS and Kujula.

	Segment translation (cm)	r value	p value
45°	NPS	0.08	0.66
	LEFS	-0.01	0.93
	Kujula	0.03	0.84

r value: Correlation coefficient value - p value: Probability value

Table 4: ICC for AAE measurement

AAE	ICC	(95% CI)	
		Lower bound	Upper bound
30°	0.71	0.48	0.85
45°	0.76	0.56	0.88

ICC: Inter class correlation coefficient value
CI: Confidence Interval

Fig.1: Starting position for JPS using digital goniometer.

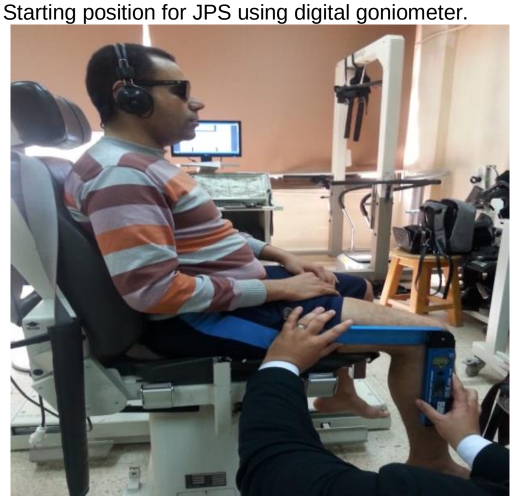


Fig. 2: Active joint position at target angle of 30˚ using a digital goniometer

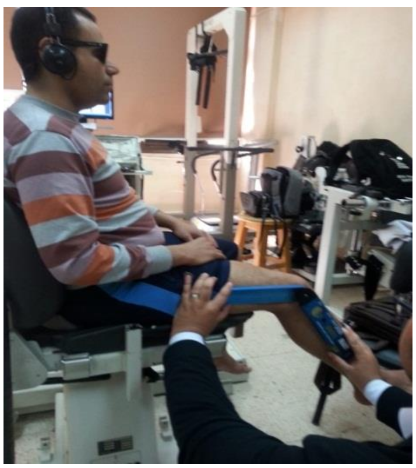
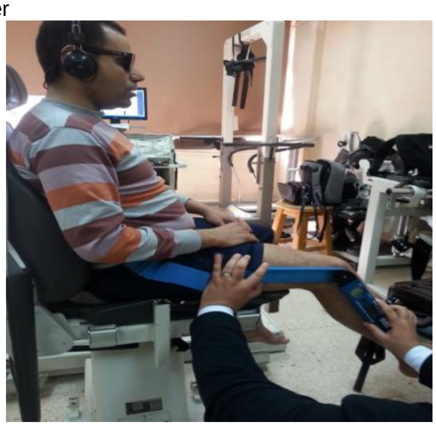


Fig. 3: Active joint position at target angle of 45˚ using a digital goniometer



DISCUSSION

Proprioceptive systems have important impacts in controlling knee function during various activities and affect the development and progression of knee OA**.** Its deficiency can lead to the progression of knee symptoms pain and dysfunction. The digital goniometer is an applicable tool used to measure active repositioning sense in the clinical setting but till now its validity and reliability are questionable in patients with knee OA. The measurement of joint position sense used in a study conducted by Çetinkaya et al[18] and the inter-tester reliability was tested. Only the intra-observer reliability was studied where the same author conducted all the measurements.

In the current study there was a weak positive non-significant correlation between absolute angular error concerning proprioceptive active sense, pain score and functional performance using KAKPS and LEFS questionnaire in patients with knee OA. Results agreed with previous studies which demonstrated no significant difference between ROA neither for position[27-30]**,** or motion senses[12, 31]**.**

Although it is unclear whether proprioceptive deficits resulted in orfrom knee OA, previous literatures showed that proprioceptive deficit is a determinant variable explaining the progression and poor functional ability in patients with knee OA[32-34]**.**

In a current large longitudinal study concentrated on proprioceptive acuity[27], it became worse under non-weight-bearing (NWB) conditions at baseline. In addition, subjects had slightly increased pain and physical function scores compared with other individuals with the best proprioceptive acuity. The lack of correlation may refer to the testing position, where only the active positioning test measured in sitting position that rendered the knee joint receptors culpable without compensatory mechanisms of other joints in standing where weight bearing (WB) tests include more proprioceptive inputs[5,36] and that the results from WB tests could be confounded by patients' knee pain **[(37)].**However, the lack of muscle strength and/or balance in standing **[(19)]** was not considered in our assessment. There position strategies of ipsilateral hip and ankle joint through the co-contractions of lower limb muscles could compensate for the deficit in the WB conditions, in addition to the sensory input from adjacent hip and ankle joints might compensate for knee proprioceptive deficit. This was clear after monitoring soleus moto-neuron facilitation in healthy knee effusion[38]**.**

Results did not come in agreement with the findings of some studies that examined the proprioceptive status of knee OA patients. Subjects with knee OA are known to have proprioceptive deficit compared with age-matched controls[9,12]**.**The lack of joint capsule resiliency in OA would also be a cause of the proprioceptive deficit in knee OA patients with joint effusion. Moreover, the distension of the joint capsule alleviates mechano-receptive inputs. An abnormal afferent discharge could decrease g-motor neuron excitability, which, in turn, diminishes the excitability of muscle spindle, and finally lowers proprioceptive acuity **[(34)].**Therefore, studying the mechanical effect of effusion via stimulating capsular or intra-articular receptors is crucial to evaluate proprioceptive system in the knee joint[39]**.** Some authors considered motion sense tests than position sense tests, as indicated by the higher ICC scores especially, in non-knee OA studies[36,40]**.** However, authors did not examine the efficacy of joint effusion on AAE in the current study.

In the current study, there was moderate reliability for 30° (ICC: 0.71) and good reliability for 45° (ICC: 0.76). The results come in agreement with a previous study conducted by **Thijs et al.** **[41]** as the Halo device produced a near perfect correlation with 95% CI of 0.999–1.000. The current study revealed that proprioception deteriorated more in knee flexion position which aggravated the symptoms and signs in patients with Patello femoral pain syndrome as pain or mechanical stress proven to proportionate with proprioceptive accuracy. Thijs et al[41] revealed thatthe increase of tissue tension when proceeding inknee flexion , elicited the Golgi and Ruffini corpuscles, hence deteriorated of proprioceptive system happenedpost transplantation of allograft meniscus. In the same vein, increased tissue tension at the per patellar soft tissue with increased knee flexion may render proprioceptive input inaccurate. However,there was no comparison to a 'gold-standard' or use of radiograph, isa limitation in the study. Therefore, theprecision of any device is questionable, even though the lack of accuracy in radiographs is considered, and subjecting patients to radiation in order to evaluatethe range of motion is exhausting.

CONCLUSION

Digital goniometer is a valid and reliable tool in measuring joint ROM and is considered a cheap and portable device. It was not a valid tool in measuring knee proprioception (active repositioning test) in individuals with primary knee OA although its validity in measuring joint range of motions in different body joints. However, there was a moderate intra-rater reliability of AAE for 30˚and a good intra-rater reliability of AAE for 45˚.

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