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ORIGINAL ARTICLE

Test-Retests Reliability of Digital Photography in Measuring Quadriceps-Angle and Pelvic Tilt Angle in Healthy Population

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ABSTRACT

Aim: Capturing body images through digital photography method for calculation of quadriceps angles and pelvic position in clinical assessment is an inexpensive method. The aim of this study is to evaluate the reliability of measuring Q-angle and pelvic tilt angle with digital camera and Microdicom software.

Place and duration: University of Lahore and Tehran University of medical sciences, from June 2020 to June 2021

Methods: Bilateral lower limbs of fifteen healthy asymptomatic subjects were considered for calculations of desired angles. A 13-megapixel camera was used to capture images of quadriceps angle (q-angle) measurement in an anterior view and for pelvic angle measurement image in lateral view along with specific landmark markers on the body were captured. Images were transferred to Microdicom software for calculating desire angles. Three trails of procedures and Intra-class Correlation Coefficient (ICC) with 95% Confidence Interval (CI), Munro's classification for reliability coefficients were used for the description of degrees. Standard error of measurement (SEM) was also calculated.

Results: The Intra-class correlation coefficient values for right side Q- angle was 0.949(0.878-.981) and for left side it was 0.924(0.819-0.972) and <0.005 significant p-value. The ICC results for measuring pelvic title angle in the right side .990 (.975-.996) and left legs were .991 (.974-.997). Showing that the results were highly reliable and significant (p<0.005).

Conclusions: The q-angle and pelvic angle measured with digital image have excellent consistency and reliability.

Keywords: angle, asymptomatic, Images, pelvic, quadriceps,

INTRODUCTION

Human body alignment and movement have great interaction with each other to perform certain activity. In an ideal condition, human body exerts minimal muscles work to gain maximum stability by controlling external loads and body structures, during dynamic task performances, which ultimately help in producing effective locomotion system [1]. During the assessment of patients in physical therapy, the evaluation of skeletal alignment and range of motion (ROM) of joints for diagnosis and treatment planning of short term and long term goals is essential. It is recommended that dynamic and static postural stability is necessary for normal functioning of muscular and skeleton system. Therefore, postural evaluation requires more attention because it is a complex system that has many factors.

The latest development in the field of technology is providing alternative procedures for measuring postural assessment through angular and linear measurement is photogrammetry. This Procedure is arts, technology and science and for obtaining valid measurement through recording and capturing photographic images of any object or surroundings [2]. With the help of photogrammetry, recording of different body parts and their interaction with other parts and any change in their respective positions is possible to record [3]. This procedure can be used to evaluate any change in structural shape of human posture more reliable compared to ordinary visual procedure of assessment. It will also have great benefit sports injuries and activities [2]; specially in those who are developing patellofemoral dysfunction and pain [4].Chondromalacia and patellar later dislocation are secondary problems, generated due to changes in normal biomechanics of weight transfer and muscles work performing around the knee, which ultimately produces varus or valgus knee [5]. Previously Quadriceps angle, which is also called quadriceps angle of pull, was considered as responsible for proper functioning and alignment of lower limb and knee joint [6]. According to Brattstorm, Q-angle is defined as the angle formed by quadriceps muscle and patellar tendon. It can be calculated by drawing an imaginary line from the tibial tuberosity to the canter of the patella and another line from the canter of patella to the anterior superior iliac spine [7] [6]. Q-angle is a biomechanical indicator reflecting quadriceps's activity in thigh and patella movement in knee joint grove. The proper calculation of q-angle will be useful for the postural assessment of lower limb [8].

Therefore, observing and finding biomechanics is critical not only for people who are suffering from problems but also for those who want to improve their physical activities and games and sports [9, 10].

Low back and knee joint pains are of major sources of disability in the general population [11]**.** These are secondary to the postural faults and increased body weight or load on the back [12] and in knee, which ultimately lead to morphological changes in lumber spine, pelvic [13], hip and knee. Previous researchers have reported different reasons for less availability of studies, which associates specified musculoskeletal problems or injuries to altered posture, that's why there is a need to generate a reliable tool for assessment and diagnosing the postural faults and finding the more specific structures involved at gross level in the field of physical-therapy and rehabilitation [14]. Digital photography can help diagnosing the postural changes. Therefore, this study aimed to test- retest reliability of digital photography in measuring Q-angle and pelvic tilt in the healthy population.

MATERIALS AND METHODS

After approval from the ethical committee of Tehran University of Medical Sciences (TUMS), present study was performed at the department of physiotherapy in school of Rehabilitation, TUMS, Iran. A total of 15 subjects (30 Limbs) of both gender, aged between 20 and 45 years with asymptomatic knees were included. Participants with a history of trauma, amputation, balance or neurological disorders, congenital deformities and surgical procedures in lower limb were excluded from the study. Consent was taken before start of procedure from each participant.

Experiments: The whole procedure was performed in a non-reflective environment at normal room temperature and brightness of approximately 1600 lumens. OPPO F1s mobile camera with specifications of 13-megapixel, focal length aperture (f/2.2), Periscope zoom lens with zoom 1.5 x used. The camera was fixed on a tripod with height of 90 centimetres (cm) at a distance of 290 cm from subject. The floor was marked at a distance of 7 cm between the heels with 10-degree external rotation of the feet. To capture image, each subject stood on the floor already marked with tape. The subject with his arms crossed over the chest and

reflective stickers pasted on the intended points on the body landmarks, after careful palpitation of marker by two trained physical therapist. Angle calculated by using Microdicom software by drawing lines and uniting specific points.

For quadriceps angle measurement, specific markers were pasted on anterior superior iliac spine (ASIS), centre of patella (CP) and tibial tuberosity (TT) to capture image in anterior view, For calculation of angle in Microdicom software a line from ASIS to CP was drawn and another line from TT to CP and upward was drawn. Angle is formed between junctions of these two lines joining each other at CP (Figure 1).

Figure 1 measurement of Q-angle from ASIS, CP and TT with Microdicom software

For pelvic angle measurement, the makers were pasted at anterior superior iliac spine (ASIS) and posterior superior iliac spine (PSIS) on both limbs and image was captured in lateral view. A horizontal line drawn in Microdicom from ASIS to PSIS and angle between horizontal plan and line joining ASIS to PSIS is calculated (Image 2).For reliability test each procedure was performed three times with 2 minutes interval, to check the reliability of digital photography while calculating Q-angle and pelvic tilt.

Figure 2 Measurement of Pelvic tilt from ASIS and PSIS with Microdicom software

Figure 2 pelvic tilt angle

In order to measure reliability, Intra-class Correlation Coefficient (ICC) with 95% Confidence Interval (CI) was used. Relative intra-session reliabilities were measured by using a 1-way random model of the intra-class correlation coefficient [14]. Munro's classification for reliability coefficients was used for the description of degrees based on the mentioned values: 0.00- 0.25, little reliability, 0.26-0.49, low reliability; 0.50-0.69, moderate reliability; 0.70-0.89, high reliability; and 0.90-1.00, very high reliability [15]. Absolute reliability was assessed by using Standard Error of Measurement (SEM) [16]. Data were analysed by using SPSS version 25.

RESULTS

Mean values of the Q-angle and pelvic tilt measured by digital photography on right and left sides of healthy subjects in three trails are shown in table I. along with the standard deviations (SDs).

Table I: Data showing Q-angle and pelvic tilt angle of healthy subjects with digital photography (left and right legs; n=30)

Variables	Right Side			Left Side		
	Test 1 Mean (SD)	Test 2 Mean (SD)	Test 3 Mean (SD)	Test 1 Mean (SD)	Test 2 Mean (SD)	Test 3 Mean (SD)
Q-Angle	17.60 (5.46)	17.29 (5.18)	17.47 (4.19)	17.31 (2.93)	16.85 (4.09)	17.67 (4.73)
Pelvic Tilt angle	11.13 (5.53)	11.05 (5.83)	11.40 (5.66)	9.02 (7.08)	9.89 (7.33)	9.39 (7.29)

The Intra-class correlation coefficient values for right side Q-angle was 0.949(0.878-.981) and for left side it was 0.924(0.819-0.972) which showed that the test was very highly reliable and the results were also significant ($p<0.005$). The ICC results for measuring pelvic title angle in the right and left legs were 0.990 (.975-.996) and 0.991 (0.974-.997) respectively which also showed that the results were highly reliable and significant as shown in table II.

Table II. Test-retest Reliability of digital photography for measuring Q-angle and Pelvic title angles of healthy subjects (total; n=30)

Variables	Right Side					Left Side			
	ICC (95% CI)	P-Value	SEM	CV	N size	ICC (95% CI)	P- Value	SEM	CV
Q-Angle	0.949 (0.878-.981)	0.001	0.04	8.651	15	0.924 (0.819-0.972)	0.001	0.566	8.962
Pelvic Tilt	0.990 (.975-.996)	0.001	0.141	10.535	15	0.991 (0.974-.997)	0.001	0.063	12.354

DISCUSSION

In this study, same-day test-retest reliability of measuring right and left q-angle and pelvic tilt angle by digital photography method were investigated for healthy subjects in standing position.

Postural evaluation with most of the procedure is difficult in clinical practices due to their health hazards, cost, invasive procedures, and technical trainings therefore the practical methods are more convenient[1].

Mostly clinician uses the visual postural assessment with the help of anatomical landmarks in their practices but this method is less reliable then computerized measurement especially when evaluating minor changes or problems[2]. This may be due to

thickness of connective tissues and obesity which create problems in palpating landmarks[3]. In current study observation suggested is, if ASIS, PSIS and other landmarks are not palpate able then measurement is not useful.

In Intra observer reliability of tool, No significant difference was found in current study, which shows there was no effect of inconsistent protocols and other factors on measurement which is significant[4].

For intra-observer reliability, the correlation coefficient obtained between responses of same subject at different time points was above 0.90 for all cases and trails with P<0.0001 represents excellent results. Which mean the angles measurement technique is reliable.

The value range of ICC are from 0 to 1.0, with 1.0shows complete accepted within observers whereas the ICC values in negative are interpreted as having no reliability. The degree of reliability coefficients will change with the influence of factors that are contributing to error, which includes training, experience of the observers and method.

Few previous studies report some mistakes like inadequate placement of markers, wrong placement of Camera, variation in subject position during photogrammetric measurement of angles [1, 3]. These mistakes reduce the reliability of the procedure. In this study attention and precautions were taken while performing procedure. In current study the therapist was trained properly by senior supervisor and researcher, placed landmarks were rechecked by another trained observer. The intra observation results were good and reliable for Q-angle and pelvic tilt angle.

Traditionally q-angle was measured by radiological method and goniometric procedure, both procedures have limitations like radiography is expensive method and it has side effects on heath. Many studies have been conducted to predict about q-angle, almost all have different values for both male and females around the world. This study aims to establish better tool for calculating q-angle. For a comprehensive diagnostic procedure alone photogrammetry is not enough, all clinical finding should be considered in examination[1]. Therefore any minor change just like in current study has changes in right and left side; these changes may be neglected and considered in cautions.

CONCLUSIONS

The angle analysed from anterior and lateral view with photogrammetry has excellent consistency and reliability, procedure is helpful in finding anterior, posterior pelvic tilt angle and q-angle .therefore this tool may help the researchers and clinicians to evaluate postural measurement and changes. Suggested furthermore studies should be conducted to have better ideas and exact value for q-angle for both genders.

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