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Correlation between Clinical and Radiological Findings in Individuals with Patellofemoral Pain Syndrome

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Abstract

AIM: Firstly, this study aimed to compare between different clinical findings commonly measured in physical therapy among healthy individuals and those with patellofemoral pain syndrome (PFPS). Secondly, this study aimed to investigate the correlation between several clinical findings in individuals with PFPS including Craig's test, quadriceps (Q) Angle and Kujula test and the findings of computed tomography (CT).

METHODS: Twenty-nine healthy individuals and thirty individuals diagnosed with PFPS were enrolled in the study after signing a consent form. The examiner took the medical history and fills the data collection sheet for each participant and they were examined for the following measures Craig's test, Q-Angle and Kujula test. The participants in the experimental (PFPS) group were further investigated using CT.

RESULTS: There was no significant difference between patients and controls in the mean age, weight, height and BMI. Significant decrease of Kujula in patient group compared to control group (p=0.0001) and there was significant increase of Q angle and Criage test in patients than controls (P= 0.026 and P= 0.017 respectively). There was significant positive correlation between Kujula and congruence angle and patellar weber (P < 0.01). Moreover, significant positive correlation was observed between Craig's test and patellar tendon ratio. While, negative correlation was found between Q angle and patellar tendon ratio.

CONCLUSIONS: Kujala Score, Q angle and Criage test were proved to be valid and sensitive to clinical changes in PFPS and have moderate to good concordance with CT parameters.

Introduction

Patellofemoral pain syndrome (PFPS) is considered one of the most common knee problems among active young individuals [1]. It affects 25% of all knee injuries seen in orthopedic and sport clinics [2]. Practice in sports and daily activities may be affected by PFPS and more individuals continue to have problems even after a full treatment program had been introduced [3], [4]. The individuals who are diagnosed with PFPS have a reduction in activities of daily living (ADL), work and sport contribution [5]. PFPS have been found in athletic people who participate in sportive events, military persons and general population [6]. The etiology of PFPS is multifactorial in nature. There was a good level of evidence existing the relationship between PFPS and patellar alignment and mechanics, foot mechanics, and hip strength and mechanics [7].

Deterioration of functional level and increased pain intensity could be associated with muscle weakness, increased soft tissue tightness, excessive foot pronation, increased Q angle, external tibial torsion and increased femoral anteversion, less efficient movement, and increased levels of anxiety and fear-avoidance beliefs [8]. So, our knowledge of the most important elements related to pain and function may assist in selecting the most valuable treatment method for individuals with PFPS that will improve their pain and level of function.

There was evidence that both clinical and biomechanical testing have a conclusion that increased patellofemoral contact pressure were associated with increased femoral ante-version but still not correlated with the radiological testing [9], [10]. During loading the response phase of the normal gait cycle the femur internally rotated in the transverse plane and adducted in the frontal plane [11]. There have been conflicting

evidence regarding the association of femoral anteversion and PFPS development [12], [13].

There was no definite evidence of the association of quadriceps (Q) angle as a risk factor in developing PFPS. Change in Q angle from normal values has also been related to PFPS [14], [15]. Although many studies have not found any differences in Q angle when comparing individuals with PFPS with healthy individuals [2], [16], [17], [18]. In addition, the specific point of angulation that is thought to be of great value to precipitate a person to knee symptoms still be unclear [14], [15]. Excessive Q-angle alone is not responsible for developing PFPS. In a previous study there was 16% of the males and 20% of the females in the control group had greater Q-angles without any knee symptoms [19].

The measurements provided by a multi-detector computed tomography (MDCT) scan of the knee joint, such as trochlear groove-tibial tuberosity (TG-TT) distance and the kind of patella are of increased importance to the clinician in selecting the appropriate therapeutic procedure. The additional value of MDCT with respect to conventional axial radiographic projections of the knees at 30° flexion is providing the assessment of patello-femoral joint in the axial plane, with the lower extremity in extension and in early degrees of flexion. A CT scan performed with the knees in at least 20° flexion allows to examine the behavior of patella when it enters in the femoral trochlea, identifying the most serious cases in which the patella is dislocated in flexion [20].

The aim of this research work was to investigate how different physical measures including level of knee joint dysfunction using Kujula scale, Q angle and femoral anteversion using criage test can predict the development of PFPS in comparison with a control group of healthy individuals. Also, to investigate the relationship between these physical measures and radiological findings using a multi-detector computed tomography (MDCT) scan.

Material and methods

Participants

Ethical approval obtained from the review board at Faculty of physical therapy, Cairo University before conducting the study [No.: P.T.REC/012/002961] which followed the guidelines of declaration of Helsinki on the conduct of human research. Individuals approached between September 2020 and March 2021 to participate in this cross-sectional study.

The sample includes two groups (control and another experimental) (A n = 29 & B n = 30) for comparison purposes among normal population who's their age between 16-40 years of normal nonathletic individuals [21], [22]. Individuals had participated in this study if they were diagnosed by orthopedic surgeon with PFPS. The control group will be an age matched by normal volunteers. Then, participants of both groups provided informed consent after explaining the nature, purpose, and value of the study, emphasizing their freedom to refuse or withdraw at any time, and about the confidentiality of information. The convenient sample of fifty-nine recruited from our clinic of the faculty of physical therapy, Cairo University and age match healthy volunteers were enrolled and assessed for their eligibility to participate in this study and assured about anonymity through coding of all data

In the experimental group the participants complained from pain in one knee, with a duration of signs and symptoms more than 4 weeks, they had gradual onset of pain not initiated by trauma, and they had peri-patellar pain with at least three of the following tasks: manual patellar compression on the femur at rest or during an isometric quadriceps contraction, palpation of the postero-medial and postero-lateral aspects of the patella, squatting, stair climbing, kneeling, or prolonged sitting. The participants excluded from the study if they had: Previous patellar instability, Knee surgery over the past 2 years, infra-patellar bursitis or tendonitis, intra-articular blockage, rheumatoid arthritis, ligamentous laxity, Plica syndrome, Osgood Schlatter's disease, infection, malignancy, musculoskeletal or neurological lower extremity involvement that interferes with physical activity, and pregnancy.

Individuals should have one lower limb examined unless they have bilateral affection, in which case the most affected side was examined. Data was collected during one assessment session that lasted approximately 30 minutes. We collected data during the same assessment session to avoid any change in variability between individuals regarding the parameters tested. All participants knew the purpose of the study and testing procedure fully explained and all relevant questions answered. Upon agreement to participation, an informed consent was signed in. The participant's personal data were collected, and the data collection sheet was filled in.

Instrumentation

Data collection sheet

The subjects' age, gender type, height, weight, history, mechanism of injury, present illness duration, and location were recorded. The groups were matched according to gender, age, height, body weight and physical activity.

Kujula

The researchers used the translated Arabic form of Kujula questionnaire. It is a screening tool used

to examine patellofemoral pain in adolescents and young adults, with an ordinal response style. It is composed of 13-item [23].

Femoral ante-version

It was assessed by using Craig's test in which the individual was laid in his stomach with the knee flexed to 90° [24]. The digital goniometer was turned to zero on a vertical surface and put on the medial aspect of the lower leg, just proximal to the medial malleolus. The examiner palpated the posterior part of the greater trochanter of the femur by one hand. While rotate the hip till the most protruding part of the greater trochanter reached the horizontal plane. The angle of ante-version was measured between the lower leg and the vertical in degrees.

Q-Angle

It was measured with the knee in full extension with the subject lying on his back The angle formed by the intersection of the line from the anterior superior iliac spine to the midpoint of patella with the line from the center of the patella to the tibial tubercle was measured in degrees with a universal goniometer [25]. At first the examiner palpated the anterior superior iliac spine and asked the participant to keep his index finger pointing down over this landmark during the assessment. An individual was asked to relax the quadriceps muscles during the assessment. Everyone then asked to place their feet in a neutral position as variability in foot position has been shown to affect Q-angle measurement 26.

Computed tomography CT scan

Each participant in PFPS group was assessed for radiological finding using multi-detector CT (MDCT) which was 16 rows. The unit found in El dokki center for radiology was 128 slices light speed VCT (GE Healthcare, Wis, USA) [27]. A spiral acquisition method was used to gain our images. We did not use intravenous iodinated contrast in our examination [28]. Each participant was laid in his back with knees positioned in middle of gantry. The feet should be stabilized and toes directed to ceiling to minimize limb mobility during examination. We set up the CT scout on sagittal and frontal planes. The scan interval should involve musculotendinous junction of the quadriceps muscle proximally to patellar tendon insertion on tibial tubercle distally. A superimposition of axial view images were obtained by passing through tubercle of tibia (the most prominent point) and trochlear groove (the deepest point) to take the measurement of TG-TT distance. A sagittal multi-planner reconstruction (SMPR) was obtained to take the measurement of Insall- Salvati raio. The rest of the measures were obtained from axial views.

Data analysis

T test was conducted for comparison between groups. Person correlation coefficient was conducted to investigate the correlation between variables. 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

Table 1 showed the subject characteristics of both groups. There was no significant difference between both groups in the mean age, weight, height and BMI ($p < 0.05$).

Table 1: Comparison of the mean age, weight, height and BMI between group A and B

	Group A	Group B			
	x̄ ± SD	x̄ ± SD	MD	t-value	p- value
Age (years)	24.44 ± 7.19	26.3 ± 8.44	-1.86	-1.22	0.22
Weight (kg)	76.31 ± 12.36	74.61 ± 16.41	1.7	0.61	0.54
Height (cm)	174.62 ± 8.3	171.2 ± 12.17	3.42	1.71	0.1
BMI (kg/m²)	24.97 ± 3.4	25.27 ± 4.03	-0.3	-0.42	0.67

x̄, Mean; SD, Standard deviation; MD, Mean difference; p value, Probability value.

There was a significant increase in Kujula of group (A) compared with that of group B (0.0001), while there was a significant decrease in Q angle and Criage test of group (A) compared with that of group B (0.026 and 0.017 respectively) (Table 2).

Table 2: Comparison of the mean Kujula,Q angle and Criage test between group A and B

	Group A	Group B			
	x̄ ± SD	x̄ ± SD	MD	t- value	p- value
Kujula	100 ± 0	74.28 ± 11.32	25.72	17.31	0.0001*
Q angle	10.22± 3.94	10.52± 6.03	-0.29	-0.222	0.026*
Criage test	30.97± 9.77	34.37± 11.27	-3.4	-1.24	0.017*

x̄, Mean; SD, Standard deviation; MD, Mean difference; p value, Probability value; * Significant

There was a positive significant correlation between Kujula and congruence angle and Patellar weber ($P < 0.01$). However, there was no correlation between Kujula with patellar tendon ratio ($P=0.14$). There was a significant negative correlation between Q angle and patellar tendon ratio ($P = 0.009$).

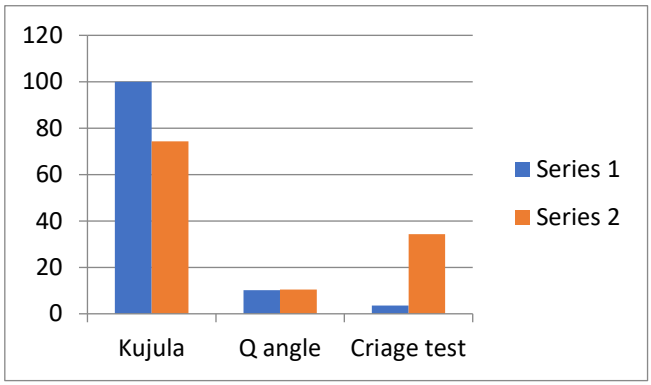

Figure 1: The differences in clinical findings between healthy and PFPS individuals

While there was no correlation between Q angle with congruence and patellar weber. There was a significant positive correlation between Criage test with Patellar tendon ratio ($p < 0.05$). While there was no correlation between Criage test with congruence angle (P= 0.78), also between Criage test and Patellar weber (Table3).

Table 3: Correlation between the clinical and radiological parameters in PFPS group (B)

		r value	p value
Kujula	Congurence angle	0.63	0.015*
	Patellar tendon ratio	0.63	0.14
	Patellar weber	0.62	0.018*
Q angle	Congurence angle	0.32	0.1
	Patellar tendon ratio	-0.49	0.009*
	Patellar weber	-0.009	0.97
Craig's test	Congurence angle	0.069	0.78
	Patellar tendon ratio	0.48	0.04*
	Patellar weber	0.02	0.93

r value, correlation coefficient value; p value, probability value, * Significant

Discussion

Most of the previous studies were dependent on specific population (military and sportive persons) that may perform higher demand activities than the general populations. Also, there may be a difference in age compared to our study samples. Many previous studies were performed to examine the association between many variables such as BMI, height, mass, age, gender, hip muscles weakness and the prevalence of PFPS, however there was no significant association between them [6], [29], [30].

Regarding Kujula questionnaire, the current study showed a positive correlation between Kujula scores and Patellar weber and congruence angle. Similarly, Watson et al [31] argued that 2 of 13 questions were the most misinterpreted and were related to clinical meanings such as “atrophy” and “patellar subluxation”. In fact, these clinical words were described and clearly explained in the Thai Kujala Patellofemoral Questionnaire [32], [33], [34]. In the contrary to our results there was a lack of relationship between measures of muscle strength and length, structural characteristics, and quality of movement with function and pain in individuals with PFPS. The relationship between muscle weakness and dysfunction was based on findings that quadriceps strength related to function in individuals with knee osteoarthritis [35,36]. And there was less evidence in individuals with PFPS than those without PFPS [2], [17], [37]. Also, Powers et al [38] in a previous study concluded that there was no significant correlation between function level and quadriceps strength which did not come in agreement with our findings which may be explained as using different sample population and different functional scales (functional assessment tool).

In the current study there was a significant positive correlation between Criage test with Patellar tendon ratio ($p < 0.05$). Craig’s test is the most used physical examination tool for measuring femoral ante-version. Moreover, for Craig’s test, an increased femoral ante-version may be a risk factor for development of PFPS and is measured by Craig's Test clinically using a goniometer. Individuals with PFPS had been found to have greater degrees of femoral internal rotation [13]. Greater femoral ante-version had been associated with increased degrees of passive hip internal rotation ROM [39].

In a previous study using dynamic MRI during a single limb squat they found that lateral patellar tilt and displacement was occurred which might be due to internal rotation of the femur against movement of the relatively fixed patella [40]. So, our results provide support to that hip motion may contribute to changes in the mechanics of patellofemoral joint. There is high evidence to support the relationship between limb alignment and patellofemoral joint mechanics under static posture. Increased knee abduction had been linked to development of PFPS [17]. Also, increased medial femoral rotation has been shown to be related to development of PFPS [36], [40], [41], [42]. Increasing femoral ante-version could place the femur into a more internally rotated position, so, pushing patella inwards. Also, in-toeing gait is associated with increased femoral ante-version [41] which is associated with lateral rotation of tibia [43] which might push the tibial tuberosity laterally and hence increase patellar tendon ratio [44]. Increased femoral ante-version had been linked to be related to cause more internal rotation of the hip [45], [46]. Also, the weakness of hip external rotators that are responsible for controlling hip internal rotation ROM during weight-bearing activities might lead to increased internal femoral rotation and precipitate to PFPS development [47].

However, in the current study there was no correlation between Criage test with congruence angle (P= 0.78), also between Criage test and Patellar weber. Our results came with that was found in a previous study comparing the Craig’s test and computed tomography (CT) in determining femoral internal rotation ROM in individuals with anterior cruciate ligament (ACL) injuries, results showed that there was no significant correlation between the two methods [45]. Also, in another study conducted by Tamari et al [48] reported that the depend on usage of the greater trochanter as a bony marker could cause a palpation error in Craig’s test. The big and irregular shape of prominent part of the greater trochanter makes it difficult to calculate the angle at which the greater trochanter reaches its horizontal position accurately. Another reason for the inaccurate measurement in Craig’s test may be related to use of tibial inclination as an indicator for hip internal rotation ROM. Ruwe et al [44] reported that also, the increased laxity of the knee ligaments might bias the findings of Craig’s test. Also, in another study the authors reported that any increase in the knee joint space biased the measurement of angle between the vertical line and the tibial crest during performing the test [49]. In a recent study the authors did not find any valid benefit of using Criage

test as a measure of femoral internal rotation ROM when compared with computed tomography (CT) although its clinical significance [50].

Although, our results did not support that of other studies in which PFPS individuals did not have greater degrees of hip internal rotation than control [51], [52]. There was a decline in hip internal rotation ROM in individuals with PFPS than control group during running, hopping, and squat which could be a compensatory plan to decrease painful movement [52]. Also, there was no difference between individuals with PFPF and the control group in hip internal rotation ROM during descending stairs although significant differences in hip muscle strength were found which could be due to low impact task was examined [51].

Q angle has become an important issue in assessing knee joint function and in determining knee health in individuals complaining from an anterior knee pain [52]. The Q angle is usually considered excessive when it enhances the lateral pull of the quadriceps tendon on the patella and initiates PFPS [53].

Greater Q angle might medially push the patella and laterally push the tibial tuberosity so increasing stresses on the patellofemoral joint during closed chain activities [54], [55]. However, significant negative correlation was observed between Q angle and patellar tendon ratio (p=0.009). The measurement of the Q angle in Arab population (males and females) was greater than what had been found in other countries and ethnicities [56].

However, in the current study there was no correlation between Q angle with congruence and patellar weber. In a previous study there was no significant association between the Q angle measurement and the position of patella using axial computed tomography intersecting the midpoint of articular cartilage of the patella in full extension [57].

The findings of this study showed a reduction in Q angle in patients with PFPS than controls. So, the patellofemoral joint should be examined in different positions of knee flexion [58]. The measurement of Q angle can be altered due to many factors which can change the pattern of knee function which include the pelvic alignment, femoral rotation, tibial rotation and patellar position and the position of foot [55], [59].

So, Q angle may be of great value due to increased anterior pelvic tilt, femoral ante-version and knee abduction, and external tibial torsion which could change the position of bony markers used to measure the Q angle [40]. In a study conducted by Hand and Spalding [60] they found that the examination of Q-angle was a poor predictor for development of PFPS. Also, in a previous study there was no significant support that Q angle as a cause for developing PFPS, although alteration in the Q-angle measures could be related to an increased occurrence of PFPS [48].

Conclusion

This study concluded the accuracy of the clinical evaluation using physical examination including (Kujula, Criage test and Q angle) that can be used in addition to CT measurement. Also, this study recommends the importance of changing the modifiable risk factor (Q angle and the antiversion angle) that can be modulated to enhance the different conservative treatment in individuals with PFPS.

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Ethical approval

Ethical approval was obtained from the scientific research ethical committee in faculty of physical therapy, Cairo University [No.: P.T.REC/012/002961]

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