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Relationship between Quadriceps and Femoral Anteversion Angles in Patients with Patellofemoral Pain Syndrome

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ABSTRACT

Background: *Patellofemoral pain syndrome (PFPS) is a common orthopedic complaint frequently seen in physiotherapy practice. Most of these patients can be successfully treated once the contributing factors are accurately identified. Malalignment of the lower extremity particularly the excessive quadriceps angle (Q-angle) and femoral anteversion angle have been implicated as contributing factors of PFPS.*

Objective: *The purpose of this study was to investigate the relationship between the Q-angle and femoral anteversion angle in patients with PFPS.*

Subjects and Methods: *Thirty patients (twenty one females and nine males) suffering from PFPS had participated in this study with mean age, weight, and height 23.87(±6.03) years, 71.83(±16.3) kg, and (165.09) ±5.84 cm respectively. Q-angle and femoral anteversion angles were objectively measured using standard goniometer.*

Results: *Pearson's correlation analysis revealed a significant positive correlation between the Q-angle and femoral anteversion angle in patients with PFPS (r=0.7, p=0.0001).*

Conclusion: *This study proved that the patients with PFPS require precise physical examination for accurate rehabilitation. In addition, the finding implies that the increase in the Q-angle will lead to an increase in the femoral anteversion angle and vice versa. Consequently, this may help physiotherapists to understand that the factors which increase the Q-angle will increase the femoral anteversion angle and vice versa. In turn, these factors should be considered carefully in designing the rehabilitation programs for such cases.*

Keywords: *Patellofemoral Pain Syndrome, Risk Factors, Q-Angle, Femoral Anteversion Angle.*

INTRODUCTION

Dye, 2001 has described patellofemoral pain syndrome (PFPS) as the "Black Hole of Orthopaedics" because of differences in reported etiologies. It was more prevalent in female than in male with incidence rate of PFPS in females has been reported to be 2.2 times greater than in males (Robinson and Nee, 2007). PFPS constituted 17% and 33% of knee pathologies in men and women, respectively. The force acting on the joint was 20% more in women due to the mechanic disadvantage caused by the short moment arm of the femur. The lower contact area between surfaces due to the smaller dimensions of bone structures in women increases the pressure in unit area (Serrão et al., 2005).

Lower extremity alignment has been proposed as a risk factor for acute and chronic lower extremity injuries, including patellofemoral syndrome, anterior cruciate ligament injuries,(Griffin; 2006, Myer et al.; 2008,and Daneshmandi & Saki; 2009) medial tibial stress syndrome, stress fractures, and plantar fasciitis. It has been suggested that biomechanical changes resulting from abnormal alignment may influence joint loads, mechanical efficiency of muscles, and proprioceptive orientation and feedback from the hip and knee, resulting in altered neuromuscular function and control of the lower extremities (Daneshmandi & Saki; 2009, Shultz et al.; 2009). Accounting for the alignment of the entire lower extremity, rather than a single segment, may more accurately describe the relationship between anatomic alignment and the risk of lower extremity injury, because one alignment characteristic may interact with or cause compensations at other bony segments (Nguyen & Shultz; 2009).

Alignment of the hip, knee and ankle is thought to play a key role in the load distribution at the knee and, thus, the tension placed on the capsuloligamentous structures. The potential interactions among lower extremity alignment variables have been previously described as either ''correlated'' or ''compensatory'' postures. These postures were suggested to result from several factors, such as deviations in skeletal alignment (eg, when the position of one segment depends on the position of an adjacent segment) and changes toward efficient dynamic function (eg, when positioning of the limb is altered to improve neuromechanical efficiency) (Griffin; 2006).

Among these lower extremity alignment variables, the Q angle has been frequently studied, which is defined as the angle formed by a line from the anterior superior iliac spine to the patella center and a line from the patella center to the tibial tuberosity. As Q angle represent the direction of the quadriceps muscle force vector in the frontal plane, excessive angulation is thought to predispose individuals to injuries caused by abnormal quadriceps forces acting at the knee and patelafemoral joints (Pefanis et al.; 2009). Although the Q angle has been suggested as risk factors for injuries, (Pefanis et al.; 2009) retrospective risk factors study (Daneshmandi & Saki; 2009) has failed to confirm this relationship. The reason for these inconsistent finding, may be in part due to the multiple anatomical factors that may influence the magnitude of the Q angle, which may differentially impact how the Q angle relates to dynamic knee function. It has been suggested that Q angle is a composite measure of pelvic position, hip rotation, tibial torsion, patella position and foot position (Powers et al.; 2003).

Although a change in any one of these alignment characteristics could theoretically change to position of 1 or more landmarks used measure, the Q angle and thus its magnitude, research has yet to examine the collective anatomical contributions to Q angle in athletes. Determining the anatomical factors that have the potential to impact the magnitude of the Q angle may allow clinicians and researcher to better determine its role in dynamic motion and risk of knee injury (Powers et al.; 2003).

Femoral anteversion on the other hand represents a medial torsion of the femur as the femoral neck is projected forward relative to femoral condyles. Excessive femoral anteversion would essentially place the femur into a more medially rotated position, potentially resulting in a medial displacement of the patella. Hip internal rotation would effectively displace the anatomical axes of the femur into adduction and the tibia into abduction, thereby increasing the tibiofemoral angle. Furthermore, abnormal gait patterns resulting from increased hip internal rotation can also indirectly lead to compensations in other parts of the lower extremity, such as a compensatory external rotation of the tibia on the femur would position the tibial tuberosity more laterally, resulting in an increased Q angle (Gulan et al.; 2000)

Several investigations have studied gait in PFPS. It is thought that an abnormal gait pattern can lead to PFPS due to excessive flattening of the medial arch and instability of the forefoot influencing internal rotation of the tibia, compensatory internal rotation of the femur and consequently, patellar malalignment. Lower extremity alignment is an important etiological factor in PFPS. So, the purpose of this study was to investigate the relationship between the Q-angle and femoral anteversion angle in patients with PFPS.

PATIENTS AND METHODS

Patients:

Upon approval of Cairo University's supreme council of postgraduate studies and research, thirty patients (twenty one females and nine males) with patellofemoral pain syndrome (PFPS) participated in the study. Their mean ± (SD) age, weight and height were 23.87 ± (6.03) years, 71.83 ± (16.3) kg, and 165.09 ± (5.84) cm respectively. All of them were referred by the same orthopedist who was informed of patient inclusion and exclusion criteria. Patients were included if they had anterior or retropatellar knee pain from at least 2 of the following activities (Tyler et al., 2006): (1) prolonged sitting; (2) stair climbing; (3) squatting; (4) running; (5) kneeling; and (6) hopping/jumping. Moreover, patient's insidious onset of symptoms unrelated to a traumatic incident and persistent for at least 6weeks. With age ranges from 18-35 years. Patients were excluded if they had history of any of the following condition: meniscal or other intra articular pathologic conditions; cruciate or collateral ligament involvement, patellar subluxation or dislocation, Previous surgery in the knee and hip joints, and Knee and hip joints osteoarthritis.

INSTRUMENTATION

The universal standard goniometer was used to measures the quadriceps "Q" angle and anteversion angle in patients with patellofemoral pain syndrome based on the work of (Ruwe et al., 1992, Shultz et al., 2008)

Procedures

Initially, patients gave their consents to participate in the study voluntarily after a brief orientation session about the nature of the study and the procedures to be accomplished was given. For the Q angle measurement, the subjects were in standing position with feet in neutral position and quadriceps relaxed during measurement. The Q angle was measured by placing the goniometer axis at the center of the patella, with the stationary arm aligned to the anterior superior iliac spine and the movable arm aligned to the tibial tuberosity shown in figure (1) (Duffey et al., 2000). This method of assessing Q-angle, however with the use of universal goniometer, has been reported to have an ICC of 0.89 to 0.98 for intratester reliability (Shultz et al., 2006)

Figure (1): measurement of Q angle in standing position.

For the anteversion angle measurement, for assessing femoral neck anteversion the subject was lying prone. The examiner stood on the contralateral side: the right hand was used to palpate the great trochanter while the left hand internally rotates the hip, with the patient's knee flexed to 90 degrees. At the point of maximum trochanteris prominence, the femoral neck is horizontal. The angle subtended between the tibia and the true vertical, represents the femoral neck anteversion shown in figure (2), this based on the work of (Ruwe et al., 1992).This method with the use of standard goniometer has been reported to have an interclass correlation co-efficient (ICC) of 0.77 to 0.97 for intratester reliability (Shultz et al., 2006). Three repetitions were performed for each angle. The mean value of these repetitions was taken.

 

Figure (2): measurement of anteversion angle estimation

Data Collection

Data was collected into two sheets:

1-Personal data sheet: It had age, sex, height, weight.

2- Measurement sheet: It had measured the Q angle and anteversion angle in patients with PFPS.

Statistical analysis was done by using were the Statistical Package for sciences Studies (SPSS) version 18 for windows. Descriptive statistic was used to calculate the means and standard deviations of characteristics of the subjects; age in years, weight in kg, and height in cm. Pearsonṡ correlation program was used to test correlation between the Q angle and anteversion angle in patients with PFPS. The alpha level was set at 0.05 for the correlation analysis.

DATA ANALYSIS AND RESULTS

The correlation analysis between quadriceps angle and anteversion angle revealed a significant correlation between Q angle and anteversion angle as reflected by Pearsonṡ correlation program where the r value equals (0.07) and had an associated probability value of (0.0001) as shown in table (1) and figure (3).

Table (1): Correlation Analysis between the quadriceps angle and anteversion angle

Pearson correlation coefficient	
r-value	+ 0.07
P-value	0.0001
S	S

*r-value: correlation coefficient, P-value: probability, S: significance

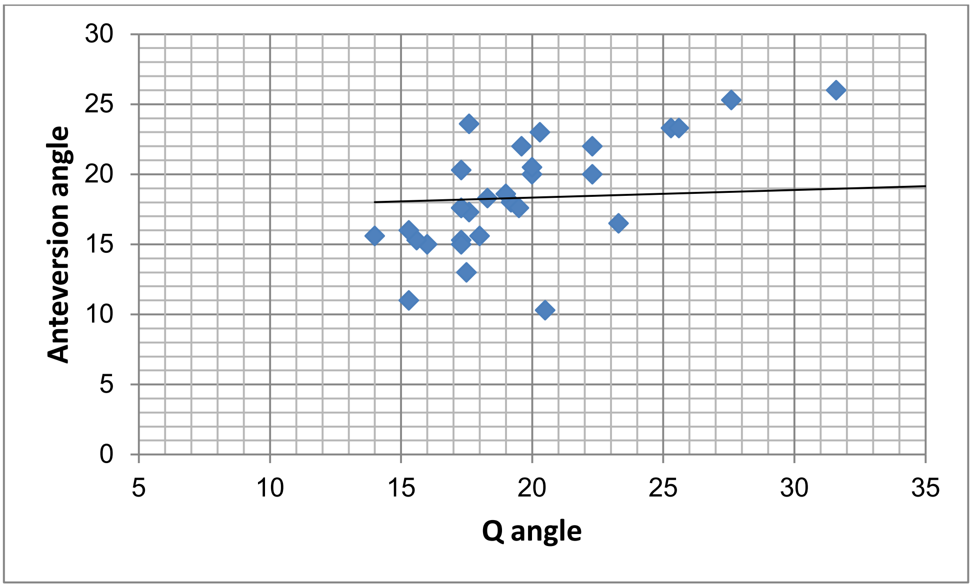

Figure (3): Correlation between quadriceps angle and anteversion angle in patients with patellofemoral pain syndrome.

DISCUSSION

The present results showed that strong and most consistent relationships between quadriceps angle and femoral anteversion in patients with PFPS. The quadriceps angle (Q angle) is an important indicator of biomechanical function and normal alignment of the lower leg, providing useful information on the functional ability of the lower extremity (Daneshmandi et al., 2011).Q angle is frequently cited as a possible predictor of knee pathology and lower limb injury (Rauh et al., 2007). Abnormally high Q angles in excess of 15 for males and 20 for females are regarded as an anatomical risk factor in the aetiology of overuse injuries of the knee (Ilahi & Kohl, 1998; Rauh et al., 2007).

Increased Q-angle was related with increased femoral anteversion. This result is similar to Nguyen et al., (2009) and Daneshmandi et al., 2011 but the previous studies in healthy subjects not PFPS patients. The present study showed that Q angle can be influenced proximally through rotation of the femur. Increased femoral internal rotation may result in a larger Q angle, as the patella would be moved medially with respect to the ASIS (femoral rotation relative to the pelvis) and/or the tibial tuberosity (femoral rotation relative to the tibia) Consequently, femoral external rotation could decrease the Q angle, as the resultant line of action of the extensor mechanism would be more in line with the ASIS and the tibial tuberosity (Powers et al., 2003). Femoral anteversion on the other hand represents a medial torsion of the femur as the femoral neck is projected forward relative to femoral condyles (Gulan et al., 2000). Excessive femoral anteversion would essentially place the femur into a more medially rotated position, potentially resulting in a medial displacement of the patella.

In fact, it has been suggested that a postural consequence of femoral anteversion is external rotation of the tibia on the femur, potentially contributing to an increased quadriceps angle (Hvid & Andersen, 1982). Furthermore, abnormal gait patterns resulting from increased hip internal rotation can also indirectly lead to compensations in other parts of the lower extremity, such as a compensatory external rotation of the tibia on the femur (Magee, 1992) which in turn would position the tibial tuberosity more laterally, resulting in an increased Q angle.

These findings are contradictory to the findings of study conducted by Nguyen and Shultz (2009) who investigated the relationships between lower extremity alignment (Q-angle, pelvic angle, hip anteversion, tibiofemoral angle, genu recurvatum, tibial torsion, and navicular drop) in healthy subjects. A possible reason why femoral anteversion did not correlated in this study, is the potential for inconsistent measurements due to poor measurement reliability. in the present study the measurement technique that we used had good reliability between testers and high correlations with intraoperative measurements. Consistent with previous authors who have reported high intratester and intertester reliability (Shultz et al., 2006; Jonson & Gross 1997).

CONCLUSION

The finding implies that the increase in the Q-angle will lead to an increase in the femoral anteversion angle and vice versa. Consequently, this may help physiotherapists to understand that the factors which increase the Q-angle will increase the femoral anteversion angle and vice versa. In turn, these factors should be considered carefully in designing the rehabilitation programs for such cases.

REFERENCES

1. Cibulka, M.T. (2004): Determination and significance of femoral neck anteversion. Phys Ther.84:550–558.
2. Daneshmandi, H., Saki1, F., Shahheidari, S., and Khoori, A. (2011): Lower extremity Malalignment and its linear relation with Q angle in female athletes. Procedia Social and Behavioral Sciences 2011;15 3349–3354
3. Daneshmandi, H., & Saki, F (2009): The study of static lower extremity posture in female athletes with ACL injuries. Harkat Sport Medicine, 1:75-91.
4. Duffey, M.J., Martin, D.F., Cannon, D.W., Craven, T., and Messier, S.P.(2000): Etiologic factors associated with anterior knee pain in distance runners. Med Sci Sports Exerc, 32:1825-1832.
5. Dye, S.F. (2001): Patellofemoral pain. Current concepts: an overview. Sports Med Arth Review.9:264–272.
6. Griffin, L.Y. (2006): Understanding and prevention noncontact anterior cruciate ligament injuries. Am J Sports Med, 34: 1512-1531.
7. Gulan, G., Matovinovic, D., Nemec, B., and Ravlic-Gulan, J. (2000): Femoral neck Anteversion: values development, measurement, common problems, DColl. Antropol, 24 (2): 521- 527.

8. Hvid, I., & Andersen, L.I. (1982): The quadriceps angle and its relation to femoral torsion. Acta Orthop Scand,53(4):577–579.
9. Ilahi, O., & Kohl, H. (1998): Lower extremity morphology and alignment and the risk of overuse injury. Clinical Journal of Sports Medicine 1998; 8, 38-42.
10. Jonson, S.R., & Gross, M.T. (1997): Intraexaminer reliability, interexaminer reliability, and mean values for nine lower extremity skeletal measures in healthy naval midshipmen. J Orthop Sports Phys Ther. 25(4):253–263.
11. Kim, J.S., Park, T.S., Park, S.B., Kim, J.S., Kim, I.Y., Kim, S.I. (2000): Measurement of femoral neck anteversion in 3D. Part 1: 3D imaging method. Med Biol Eng Comput; 38:603-9.
12. Magee, D. (1992): Orthopedic physical assessment. Saunders Co. Philadelphia. Pp.510-600.
13. Myer, G. D., Kevin, R. F., Paerno, M. V and et al. (2008). The effect of general joint laxity on risk of anterior cruciate ligament injury in young female athletes. Am. J. sports Med, 36:1078-1080.
14. Nguyen, A., Boling, M., Beverly, Levine, B., and Shultz, S. (2009) :Relationships Between Lower Extremity Alignment and the Quadriceps Angle. Clin J Sport Med. 2009 ; 19(3): 201–206.
15. Nguyen, A.D., & Shultz, S. J. (2009). Identifying relationship among lower extremity alignment characteristics. journal of athletic training, 44(5):511-518.
16. Pefanis, N., Papaharalampous, X and et al., (2009). The effect of Q angle on ankle sprain occurrence. Foot & Ankle Specialist, 2:22-26.
17. Powers, C. M., Ward, S. R., Fredericson, M., Guillet, M., and Shellock, F. G. (2003). Patellofemoral kinematics during weight-bearing and non-weight-bearing knee extension in persons with lateral subluxation of the patella: a preliminary study. *J Orthop Sports Phys Ther, 33*(11), 677-685. doi: 10.2519/jospt.2003.33.11.677
18. Powers, C.M. (2003): The Influence of altered lower-extremity kinematics on patellofemoral joint dysfunction: A theoretical perspective. JOSPT 2003; 33(11): 639-646.
19. Rauh, M., Koepsell, T., Rivara, F., Rice, S., and Margherita, A. (2007) :Quadriceps angle and risk of injury among high school cross country runners. Journal of Orthopaedic and Sports Physical Therapy.2007; 37, 725-733.
20. Robinson, R.L & Nee, R.J. (2007): Analysis of hip strength in females seeking physical therapy treatment for unilateral patellofemoral pain syndrome. J OrthopSports Phys Ther; 37: 232–37.
21. Ruwe, P.A., Gage, J.R., Ozonoff, M.B., and DeLuca, P.A. (1992): Clinical determination of femoral anteversion: a

comparison with established techniques. J Bone Joint Surg Am. 74(6):820–830.

22. Serrão, F., Cabral, C., Bérzin, F., Candolo, C., and Monteiro-Pedro,V. (2005): Effect of tibia rotation on the electromyographical activity of the vastus medialis oblique and vastus lateralis longus muscles during isometric leg-press. Phys Ther Sport; 6:15-23.
23. Shultz, S. J., Nguyen, A. D., and Levine, B. J. (2009): The relationship between lower extremity alignment characteristics and anterior knee joint laxity. Sport Health, 1(1): 54-60.
24. Shultz, S. J., Nguyen, A. D., and Schmitz, R. J. (2008): Differences in lower extremity anatomical alignment and postural characteristics in male and females between maturation groups. JOSPT, 38: 137-149.
25. Shultz, S.J., Nguyen, A.D., Windley, T.C., Kulas, A.S., and Botic, T.L., and Beynnon, B.D. (2006): Intratester and intertester reliability of clinical measures of lower extremity anatomic characteristics: implications for multicenter studies. Clin J Sport Med. 16 (2):155–161.