Original Article

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"Quadriceps angle": An Important Indicator of Biomechanical Function of Lower Extremity and Its Relation with Anterior Knee Pain

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Abstract

Introduction: Quadriceps angle (Q-angle) is an important indicator of biomechanical function in the lower extremity and describes the lateral force applied to the patellofemoral joint by the contraction of the quadriceps muscle. It is a quantitative measurement of patellar position with respect to the lower extremity alignment. Nowadays, not only in sports world but also in general population, patellofemoral pain syndrome, and dislocations of knee joint have become very common problem.

Aim: To evaluate the relationship between the anterior knee pain and Q-angle and also to find bilateral differences in mean Q-angle.

Materials and Methods: A total of 240 adults (112 males and 128 females) as cases and controls of the age group 19-35 were studied. The measurement of Q-angle was carried out on both right and left lower limbs with the help of goniometer in both cases and controls, and data were statistically analyzed.

Results: Q-angle is significantly associated with anterior knee pain in both males and females having $P < 0.000$ with females having greater Q-angle, being more prone to anterior knee pain. This study also showed bilateral differences in Q-angle in both males and females.

Conclusion: This anatomical expression of Q-angle can be used as a tool for early prediction of anterior knee pain and hence substantiates the need for lifestyle modification to counteract this syndrome at its nascent stage.

Key words: Anterior knee pain, Patellofemoral syndrome, Quadriceps angle

INTRODUCTION

The knee joint is a complex synovial joint of body that gets involved in about 50% musculoskeletal injuries and dysfunctions of which patellofemoral joint is involved in majorities of injuries and dysfunctions related to knee joint. An important measure of alignment of patellofemoral joint is quadriceps angle or Q-angle.[1] Q-angle was first described by Brattstroem[2] as an angle formed between ligamentum patellae and the extension of the line formed by the quadriceps femoris muscle resultant force with its apex at patella.

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Q-angle is formed at the point of intersection of two imaginary lines.

1. First line is drawn from ASIS to the center of patella (CP)
2. Second line is drawn from tibial tuberosity (TT) to the CP.

Q-angle is an important indicator of biomechanical function in the lower extremity and describes the lateral force applied to the patellofemoral joint by the contraction of the quadriceps muscle.[3] It is a quantitative measurement of patellar position with respect to the lower extremity alignment.[4,5]

Q-angle is widely used as an important parameter to assess patellofemoral joint functions and prevention of knee

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alignment problems in sports medicine. Increase in Q-angle beyond normal range increases lateral pull of quadriceps muscle on patella causing extensor mechanism misalignment potentiating patellofemoral pain syndrome (PFPS) which is also known as anterior knee pain syndrome.[6] It is a common condition encountered in orthopedic and sports medicine outpatient department. Persons with PFPS typically experience diffuse peripatellar or retropatellar pain. Pain is aggravated by squatting or climbing stairs or sitting with knees flexed for a prolonged period of time.[7] PFPS is more common in females than males[8] and in overweight persons.[9] The normal Q-angle varies from 8° to 12° in males and 10°-20° in females, according to different studies. A Q-angle of 20°-22° is supposed to be the predisposing factor to patellar dislocation and anterior knee pain according to previous studies.[10] A higher Q-angle increases the lateral pull of the quadriceps. Deviation from the normal range of values obtained from Q-angle measurement has been implicated in several knee disorders.[1] In Indian lifestyle, there is more risk of compressive forces on the patellofemoral joint while performing excessive flexion in sitting crossed legs and squatting position. Hence, patellofemoral joint problems and increased Q-angle seem to be more common among them.

Measurement of Q-angle clinically using a goniometer is a simple and most widely used method adopted in sports medicine. Measurement of Q-angle helps us in screening of abnormal Q-angle in persons who are more prone to wear and tear injuries of the knee joint. Moderate to substantial amounts of bilateral variability of Q-angle values have been demonstrated in individual[11] which is attributed to bilateral asymmetry in quadriceps muscle strength.[11,12] This study focuses on relation of Q-angle with anterior knee pain and also to document bilateral variability in the mean value of Q-angle in both sexes.

MATERIALS AND METHODS

This study was conducted at the Department of Orthopaedics and Physiotherapy and at the Department of Anatomy, in M. G. M. Medical College, Indore, Madhya Pradesh, India.

Material

The study included subjects both males and females between 19 and 35 years of age having anterior knee pain as cases and controls with no history of anterior knee pain or any congenital or hereditary disorders.

Methodology

The measurement of Q-angle was carried out on both right and left lower limbs with the help of universal goniometer in both cases and controls.

A goniometric method as described by Jha and Raza was adopted.[13] The measurement of the Q-angle was performed with the subject in supine with quadriceps relaxed and keeping the pelvis square. The legs were extended at the knee joint and the feet were placed in a position of neutral rotation, such that the toes were pointing directly upwards and the feet were perpendicular to the resting surface. It is the most commonly used method as it is easy to perform and is reliable.[14] Prior informed consent was obtained from each subject. Measurements were taken twice for accuracy and to take out mean in a well-lighted room. The measurements for male subjects were taken in the presence of a male attendant.

After selection of cases and controls, following groups were made further:

SMU = Symptomatic males with unilateral anterior knee pain.

SMB = Symptomatic males with bilateral anterior knee pain.

SFU = Symptomatic females with unilateral anterior knee pain.

SFB = Symptomatic females with bilateral anterior knee pain.

CM = Control males.

CF = Control females.

Statistical Evaluation

Data thus were compiled, tabulated, and analyzed statistically on word excel and SSP software. Descriptive statistics (mean ± standard deviation) of the Q-angle for the right and left lower extremity were tabulated for both males and females. Data obtained was analyzed using Student *t*-test and *P*-values were calculated.

RESULTS

Statistical calculations of cases and controls have been summarised in Tables 1 and 2.

In cases, mean Q angle of females is significantly higher than those of males when corresponding limbs of males and females are compared (Fig 1).

Mean RQA in symptomatic females with unilateral knee pain is 20.68 ± 2.541° and mean right Q-angle (RQA) in symptomatic males with unilateral knee pain is 15.17 ± 2.11°. Similarly mean left Q-angle (LQA) in symptomatic females with unilateral knee pain is 17.31 ± 2.496° and mean LQA in symptomatic males with unilateral knee pain is 13.29 ± 2.541°. Mean RQA in symptomatic females with bilateral knee pain is 20.73 ± 2.832° and mean RQA in symptomatic males with bilateral knee pain is 15.95 ± 2.371°. Similarly mean LQA in symptomatic females with

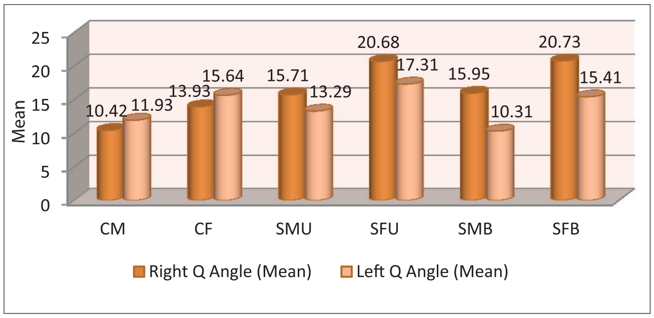

Figure 1: Means of right Q-angle and left Q-angle

bilateral knee pain is 15.41 ± 1.971 degrees and mean LQA in symptomatic males with bilateral knee pain is 10.31 ± 0.215°. In controls, Mean RQA in females is 13.93 ± 1.470° and mean RQA in males is 10.42 ± 0.225 degrees. Similarly mean LQA in females is 15.64 ± 2.11° and mean LQA in males is 11.93 ± 1.436° (Table 1).

When Student *t*-test is applied for comparing the means of Q-angles of males and females separately on both sides and *P*-value calculated, the value is found to be highly significant ($P < 0.000$).

Mean of RQA and LQA is significantly higher in females with *t* value of 11.425 and 8.485 in right and left limbs respectively. Similarly, in controls, mean Q angle of females is significantly higher than those of males when corresponding limbs of males and females are compared with *t* value of 7.571 and 8.826 in right and left limbs respectively and *P* value calculated, the value is found to be highly significant ($P < 0.000$) (Table 2).

Table 3 shows comparison between right and left Q angle in controls to study the bilateral variability. The *P*-value is significant at or below 0.05. RQA of CM is 10.42 ± 0.225, and LQA is 11.93 ± 1.436. Mean difference (ΔQ) between the two sides is −1.51. The *t*-test is applied to compare the two means; *t*-value found is −5.451 and *P*-value calculated is 0.001 which is highly significant.

RQA of CF is 13.93° and LQA of CF is 15.64°. The mean difference (ΔQ) between the Q-angles for two sides is −1.71.

The *t*-test is applied to compare the two means; *t*-value is −7.826 and $P < 0.05$ which is highly significant. The results of this study show that bilateral asymmetry exists in males ($\Delta Q = -1.51$) and females ($\Delta Q = -1.71$), with greater asymmetry seen in females as compared to males.

DISCUSSION

Quadriceps femoris angle ("Q-angle") can be considered as an index of knee function and patellofemoral kinetics.

Table 1: Mean and SD of RQA and LQA of controls and cases with anterior knee pain

Group	RQA		LQA	
	Mean±SD	SEE	Mean±SD	SEE
CM	10.42±0.225	1.74	11.93±1.436	0.185
CF	13.93±1.470	0.188	15.64±2.114	0.271
SMU	15.71±2.117	0.294	13.29±2.541	0.306
SFU	20.68±2.541	0.306	17.31±2.496	0.427
SMB	15.95±2.371	0.263	10.31±0.215	0.205
SFB	20.73±2.832	0.323	15.41±1.971	0.312

SD: Standard deviation, RQA: Right Q-angle, LQA: Left Q-angle, CM: Control males CF: Control Females, SMU: Symptomatic males with unilateral anterior knee pain, SFU: Symptomatic females with unilateral anterior knee pain, SMB: Symptomatic males with bilateral anterior knee pain, SFB: Symptomatic females with bilateral anterior knee pain

Table 2: Significant "*t*-value" of Q-angle between comparison group of males and females in both cases and controls

Cases and controls	*n*	Mean	*t*-value	*P*-value	Significance
Cases					
RQA					
Males	52	15.17	11.425	0.000	Highly Significant
Females	68	20.68			
LQA					
Males	52	13.29	8.485	0.000	Highly Significant
Females	68	17.31			
Controls					
RQA					
Males	60	10.42	7.571	0.000	Highly Significant
Females	60	13.93			
LQA					
Males	60	11.93	8.826	0.000	Highly Significant
Females	60	15.64			

RQA: Right Q-angle, LQA: Left Q-angle

Table 3: Comparison between RQA and LQA to study bilateral variability in study population (controls)

Student *t*-test	Males (*n*=60)	Females (*n*=60)
RQA	10.42±0.225	13.93±1.470
LQA	11.93±1.436	15.64±2.114
t-value	−5.451	−7.826
P-value	0.001	0.000
Significance	Highly significant	Highly significant

RQA: Right Q-angle, LQA: Left Q-angle

The findings of this study suggest that larger Q-angle is significantly associated with anterior knee pain in both males and females. Females have greater Q-angle than males, so they are more prone to develop anterior knee pain. In SMU group, mean RQA was 15.71° and mean LQA was 13.29°. In SFU group, mean RQA was 20.68° and mean LQA was 17.31°. The mean RQA in SMB was 15.95°, and 20.73° in SFB. Mean LQA in SMB group was 10.31°, and 15.41° in SFB.

In CM group, mean RQA was 10.42° and mean LQA was 11.93°. In CF group, the mean RQA was 13.93° and mean LQA was 15.64°. In this study, mean of Q-angle of patients of anterior knee pain was significantly higher than those without knee pain (controls). This suggests that high Q-angle is significantly associated with anterior knee pain. The findings of this study suggest that there is bilateral asymmetry in Q-angle. The mean Q-angle on the left side is greater than on right side in asymptomatic (control) males and females. The reason for this may be the bilateral difference in the quadriceps strength. It was found that Q-angle varied inversely with the quadriceps strength.[15] As in most of the controls right limb is the dominant limb, their RQA is smaller than LQA. It was observed that mean Q-angle of symptomatic subjects in the right limb was higher than that observed in left symptomatic subjects. This is quite opposite to what was obtained in asymptomatic subjects. There is little evidence in literature regarding this observation. It may be postulated that possibility is high that right limb of symptomatic subjects may have suffered greater trauma in addition to other intrinsic factors as compared to the left limb. As more number of cases of anterior knee pain is of the right side, the mean Q-angle value in the symptomatic group is greater on the right side than on left side. Bilateral variability in Q-angle does exist in both males and females. Therefore instead of taking mean, Q-angles must be measured separately by clinicians both on right and left side.

Emami *et al.*[16] concluded a study on 100 anterior knee pain patients and 100 controls. They found mean Q-angle for men, women and all subjects in case group was 15.3°, 20.1° and 18.0°, respectively. Mean Q-angle for men, women and all subjects in control group was 12.1, 16.7 and 14.4,° respectively. In this study, the mean Q-angle for men, women and all subjects in case group was 15.8, 20.7 and 18.25,° respectively. Mean Q-angle of men, women and all subjects in control group was 11.12, 14.78, and 12.92°. The results of this study are in accordance with the results obtained in the above study.

Livingston and Mandigo[11] conducted a study to find out whether Q-angle were bilaterally symmetric in individuals; asymptomatic and symptomatic for knee pain. They found out that there were significant right versus left lower limb differences in Q-angles, both in symptomatic and asymptomatic group ($P < 0.001$) and between males and females ($P < 0.05$). They found Q-angles are not bilaterally symmetric, with the magnitude and direction of observed asymmetry varying according to whether an individual is asymptomatic, unilaterally symptomatic or bilaterally symptomatic for anterior knee pain which is in accordance with the present study.

CONCLUSION

We concluded that larger Q-angle is significantly associated with anterior knee pain in both males and females. Moderate to substantial amount of bilateral variability of Q-angle has been demonstrated which is attributed to bilateral asymmetry in quadriceps muscle strength. Therefore, this anatomical expression of Q-angle can be used as a tool for early prediction of Anterior Knee Pain and hence substantiates the need for lifestyle modification to counteract this syndrome at its nascent stage.

REFERENCES

1. Horton MG, Hall TL. Quadriceps femoris muscle angle: Normal values and relationships with gender and selected skeletal measures. Phys Ther 1989;69:897-901.
2. Brattstroem H. Shape of the intercondylar groove normally and in recurrent dislocation of patella. A clinical and x-ray-anatomical investigation. Acta Orthop Scand Suppl 1964;68 Suppl 68:1-148.
3. Sara A, Ba T. Comparison of bilateral quadriceps femoris muscle angle in asymptomatic and symptomatic males with unilateral knee pain. Internet J Pain Symptom Control Palliat Care 2008;6;14.
4. Sendur OF, Gurer G, Yildirim T, Ozturk E, Aydeniz A. Relationship of Q-angle and joint hypermobility and Q-angle values in different positions. Clin Rheumatol 2006;25:304-8.
5. Greene CC, Edwards TB, Wade MR, Carson EW. Reliability of the quadriceps angle measurement. Am J Knee Surg 2001;14:97-103.
6. Nejati P, Forogh B, Moeineddin R, Baradaran HR, Nejati M. Patellofemoral pain syndrome in Iranian female athletes. Acta Med Iran 2011;49:169-72.
7. LaBella C. Patellofemoral pain syndrome: Eevaluation and treatment. Prim Care 2004;31:977-1003.
8. Dugan SA. Sports-related knee injuries in female athletes: What gives? Am J Phys Med Rehabil 2005;84:122-30.
9. Bentley G, Dowd G. Current concepts of etiology and treatment of chondromalacia patellae. Clin Orthop Relat Res 1984;189:209-28.
10. Nandi M, Debb S, Palc JN, Tapadard A, Roye H, Karf C. The "quadriceps angle": Correlation between clinical and radiographic measurements from a study in North Bengal. J Anat Soc India 2013;62:68-72.
11. Livingston LA, Mandigo JL. Bilateral within-subject Q-angle asymmetry in young adult females and males. Biomed Sci Instrum 1997;33:112-7.
12. Byl T, Cole JA, Livingston LA. What determines the magnitude of Q-angle? A preliminary study of selected skeletal and muscular measures. J Sports Rehabil 2000;9:26-34.
13. Jha A, Raza HK. Variation in Q-angle according to sex, height, weight, and interspinous distance. A survey. Indian J Orthod 2000;34:99-101.
14. Piva SR, Fitzgerald K, Irrgang JJ, Jones S, Hando BR, Browder DA, *et al.* Reliability of measures of impairments associated with patellofemoral pain syndrome. BMC Musculoskelet Disord 2006;7:33.
15. Raveendranath R, Nachiket S, Sujatha N, Priya R, Rema D. Bilateral Variability of the quadriceps angle (Q-angle) in an adult Indian population. Iran J Basic Med Sci 2011;14:465-71.
16. Emami MJ, Ghahramani MH, Abdinejad F, Namazi H. Q-angle: An invaluable parameter for evaluation of anterior knee pain. Arch Iran Med 2007;10:24-6.

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