Original Research Article

Establishing the better predictor for patellofemoral pain syndrome: Q angle vs intercondylar distance

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Abstract

Background: Patellofemoral pain syndrome is the most common problem in young and sporting population. Both the Q angle and the condylar distance tend to affect each other and may be used to predict the Patellofemoral pain syndrome. Q angle reflects pathomechanics and biomechanics of the patellofemoral joint. Aim of this research was to give normative data of Q angle and Intercondylar distance in Indian population and observe if any undertaken body parameters have any relation with patellofemoral pain syndrome. Here, we also aim to know which parameter (Intercondylar distance / Quadriceps angle) is the better predictor for Patellofemoral pain syndrome in young Indian populat **Subjects and methods:** This study was composed of 60 healthy individuals (sedentary). Here, 60 individuals were also included who were diagnosed with Patellofemoral pain syndrome. Q angle (goniometric method) and Intercondylar distance (manual caliper) of each participants were calculated. Comparison of body parameters was done by independent t-test. The association between the parameters and the Q angle was investigated using Pearson's correlation coefficient. Cohen's Kappa coefficient of the two parameters; Intercondylar distance & Quadriceps angle was calculated, to know which parameter can better predict the Patellofemoral pain syndrome in Indian young population. **Results:** Females had higher value of Q angle than their counterpart ($p<0.05$). On calculating the Pearson Coefficient correlation between Q angle and Intercondylar distance, we observed negative correlation between Q angle and Intercondylar distance ($p<0.05$) in sedentary. This revealed a significant discovery regarding the Indian population i.e. with the increase in value of Intercondylar distance, there is a decrease in Q angle. In this study, we also calculated Cohen's kappa coefficient and on calculation, we found that the Q angle was better indicator for Patellofemoral pain syndrome than Intercondylar distance. **Conclusion:** Quadriceps femoris angle should be used to assess the bio-mechanical function of knee joint and as an indicator to predict Patellofemoral pain syndrome. Females had higher Q angle in comparison to males, making them more susceptible to the disorders of patellofemoral joint. Q angle has far greater significance to sportspersons, especially females who involve in different competitive sports and physical activities. Thus, it's the high time to not only carry out the periodic screening for Q angle in susceptible population but also use it in clinical practice and the prognosis of affected individual after treatment.

Keyword: Patellofemoral pain syndrome, Knee joint, Q angle, Intercondylar distance, Goniometer, Sedentary

Introduction

Patellofemoral pain syndrome is the affliction of knee joint and around kneecap. It is the most common problem in the young and sporting population[1,2]. Since it is usually seen in individuals participating in sports especially in females, young or adult population, it is also named as jumper's knee. However, it can also happen in sedentary population. Indulging in any sports or physical activities has a positive impact on the human body. But there is also a greater concern of injuries and wear out among professional sportspersons who are at risk or have a history of patellofemoral syndrome[3].

Both the Q angle and the Intercondylar distance tend to affect each other and may be used to predict the Patellofemoral pain syndrome.

Intercondylar distance is the distance between appreciable femoral condyles. It is measured by using a manual caliper when volunteers stand erect in an anatomical position and then flex the leg to 90 degrees at the knee joint[4].

Quadriceps femoris angle of knee is an acute angle reflecting the placement of quadriceps musculature relative to the bony structures; pelvis, thigh bone and shinbone present below it[5].

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It was foremost explained by Brattstrom as a small angle established between patellar ligament and the extended line brought about by resistance force of quadriceps musculature with its peak at patella[6]. It is established at the meeting point of two lines; one extending from Anterior Superior Iliac Spine to centre of patella and another from tuberosity of tibia to centre of patella[7].

Several methods including goniometric and radiological method can be used to measure the Q angle. Moreover, it can be calculated in numerous positions such as supine position with knee fully extended and quadriceps relaxed, contracted or orthostatic, seated with knee fixed at 90˚ or 20˚- 30˚ along with negligible medial, lateral rotation or in a posture wherein shinbone is neutrally positioned[8].

The values of Quadriceps femoris angle documented by researchers around the globe vary. Hence, there is still no consensus regarding normal Q angle[9]. However the accepted normal Quadriceps femoris angle ought to be between 12 to 20 degrees. Q angle of an individual is said to be abnormal if male and female has value higher than 15˚ and 20˚ respectively[10].

Quadriceps angle reflects pathomechanics and biomechanics of the patellofemoral joint[4]. Quadriceps femoris angle is referred excessive when vector draw on patella exerted by quadriceps femoris musculature increases laterally which eventually potentiates disorders of the patellofemoral joint[10]. Some medical conditions associated with above par value of Quadriceps femoris angle are Anterior knee pain, Patellar overload syndrome, Hyper-mobile Knee joint, Patellofemoral instability and Dislocation of patella[11,12].

The purpose to conduct this study was to give normative data of the values of Q angle and Intercondylar distance in Indian population and analytic overview of the data. The study also aimed to know which parameter (Intercondylar distance & Quadriceps angle) is a better predictor for Patellofemoral pain syndrome in young Indian population.

Material and methods

This study was composed of 60 healthy sedentary individuals and 60 patients diagnosed with Patellofemoral pain syndrome. Subjects were selected as per inclusion and exclusion criteria. Inclusion criteria of the study was; Age:-18–35 years old[13] while exclusion criteria were; Spinal or neurological injury, diagnosis of knee disorder like fracture and dislocation of patella.[14] Measurement were done after securing the approval from the Institutional Ethical Committee (Ref. No.-TMMC&RC/IEC/19-20/116) at Teerthanker Mahaveer Medical College and Research Centre. A proper informed consent form was spread out before commencing the measurements. Additionally, a short presentation was also given so that all the participants would be accustomed after noting their name, age, sex, course and region. Q angle and Intercondylar distance of each participants were calculated.

Measurement of Quadriceps angle (Figure 1)

Goniometric method was adopted to calculate Quadriceps femoris angle. Firstly, participants were asked to be in supine position followed by extension of leg and relaxation of quadriceps musculature. Then, participants were requested to put the feet in neutral rotation in such a way that toes were facing upward and feet is perpendicular with respect to the surface. Three bony points; Anterior Superior Iliac Spine (ASIS), centre of Tibial Tuberosity (TT) and Centre of Patella (CP) were identified and marked by a marker.

For identifying CP, the contour of patella was drawn after appreciating the borders without stretching skin. The centre of patella was referred to the point where maximum vertical diameter meets with maximum transverse diameter. Centre of Tibial Tuberosity was the point having maximum appreciation. A measuring scale or tape was used to draw a straight line from ASIS to CP and another line from TT to CP.

Hinge of the goniometer (least count of the goniometer-1 degree) was placed at CP and the arm of goniometer was arranged such a way that one is positioned in the straight line drawn from ASIS to TT and another arm to line from ASIS to CP. The acute angle formed between the two arms of goniometer was recorded as Quadriceps femoris angle[4].

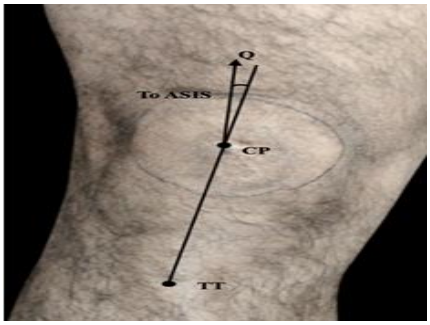

Figure 1: Q angle and bony landmarks; Anterior Superior Iliac Spine (ASIS), Centre of Patella (CP), Tibial Tuberosity (TT)[4].

Measurement of Intercondylar distance

A manual caliper (least count-1mm) was used to measure Intercondylar distance of each participant. Firstly, participants were asked to stand erect in anatomical position and then flex the leg to 90 degrees at knee joint, outcome was condyles of femur became prominent and appreciable. Manual caliper has two arms; fixed and moveable. The fixed arm was put on femoral's lateral condyle followed by adjustment of movable arm on medial condyle. Distance covered was shown in cm in caliper which was recored and written on pro forma sheet[4].

For Statistical analysis SPSS version 23 was used. Comparison of body parameters was done by independent t-test. The association between the parameters was investigated by means of Pearson's correlation coefficient. The p value ≤ 0.05 was considered statistically significant.

Calculation of Cohen's Kappa (k) was done to find out the reliability of two parameters; Intercondylar distance & Quadricep angle, in forecasting the probability of Patellofemoral pain syndrome in future.

$$k = \frac{Pr(a)-Pr(e)}{1-Pr(e)}$$

Here,

k = Cohen's Kappa coefficient

Pr (a) = Relative observed agreement among parameters

Pr (e) = Hypothetical probability of chance agreement

$Pr(e) = 1/N^2 \sum nk_1nk_2$

where N = Number of items,

Cohen's kappa coefficient (k) measures quantitative reliability between two parameters; nk_1 and nk_2.

Interpretation of values of kappa coefficient in terms of agreement,

≤ 0 = No

0.01-0.20 = None to modest

0.21-0.40 = Reasonable

0.41-0.60 = Moderate

0.61-0.80 = Substantial

0.81–1.00 = Almost ideal

Result

Table 1- Comparison of body parameters between male and female in sedentary

S.N.	Parameters	Sedentary		t-value	p-value
		Male	Female		
		Mean ± S.D	Mean ± S.D		
1	Intercondylar Distance (cm)	9.08 ± 0.39	7.95 ± 0.44	10.10	<0.05
2	Q-angle (degree)	15.11 ± 2.72	16.80 ± 1.10	3.18	<0.05

Table-1 showed the comparison of Q angle and Intercondylar distance between male and female in sedentary and both the parameters were statistically significant ($p<0.05$).

Table 2- Correlation of Q angle with Intercondylar distance in sedentary

Category	Parameters	r-value	p-value
Sedentary	Intercondylar Distance(cm)	-0.32	<0.05

Table-2 showed the correlation of Q angle with Intercondylar distance in sedentary. There was statistically significant ($p<0.05$) negative correlation between Q angle and Intercondylar distance in sedentary. This means with the increase in Intercondylar distance, there is decrease in Q angle.

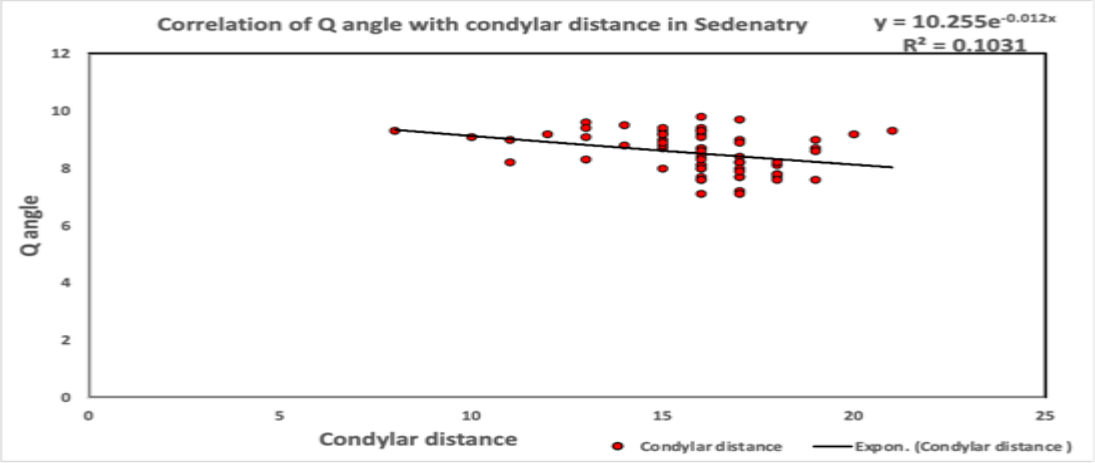

Figure 2- Depicting correlation of Q angle with Intercondylar distance in Sedentary

1-0.59

= 0.49 (Moderate)

Cohen's Kappa of Quadriceps angle for Patellofemoral pain syndrome

Out of 60 patients of Patellofemoral pain syndrome, 45 patients had abnormal Q angle and 12 had normal Q angle while in 3 patients it was confirmed that Patellofemoral pain syndrome wasn't the primary condition.

$k = \frac{Pr(a)-Pr(e)}{1-Pr(e)}$

$Pr(a) = \frac{45 + 12}{63}$

$= 0.90$

$Pr(e) = \frac{(48 * 48) + (15 * 15)}{3969}$

$= 0.64$

$k = \frac{0.90-0.64}{1-0.64}$

$= 0.72$ (Substantial)

Cohen's Kappa of Intercondylar distance for Patellofemoral pain syndrome

Out of 60 patients of Patellofemoral pain syndrome, 41 patients had Bi-condylar distance above the usual values in Indian population and 12 had usual values while in 7 patients it was confirmed that Patellofemoral pain syndrome wasn't the primary condition.

$k = \frac{Pr(a)-Pr(e)}{1-Pr(e)}$

$Pr(a) = \frac{45 + 12}{67}$

$= 0.79$

$Pr(e) = \frac{(48 * 48) + (19 * 19)}{4489}$

$= 0.59$

$k = \frac{0.79-0.59}{}$

Cohen's Kappa coefficient of Q angle was 0.72 while that of Intercondylar distance was 0.49. Hence, Q angle is better indicator for Patellofemoral pain syndrome.

Discussion

In this study while comparing the Q angle of sedentary population was found to be 15.89 ± 2.28. The value of the Q angle of sedentary of this study was similar to the findings of Prakash SS et al., 2019[15]. While reviewing literature (Omololu et al.,2009; Jha A and Raza HK, 2000), we observed that the average Q angle varies with in range 8°-22.8°[16,17]. Factors such ethnicity, sex, age and height of participants could be the reasons for this variation. Moreover, method to measure the Q angle also differ with the study. Body's position and placement of foot along with the level of contraction of quadriceps musculature also greatly influence the quadriceps femoris angle. Hence, one should consider all above factors while analysing the variations.

While examining the differences of Q angle in sedentary population on the basis of gender, Q angle of sedentary male was found to be 15.11 ± 2.72 and that of female was 16.80 ± 1.10 and the difference was a statistically significant. In this study, we can see that average quadriceps angle in female population was greater in comparison to the male population. The difference observed on the basis of gender was 1.69. However, reasoning for this revelation is still not clear. The possible reasoning to the females showing a higher Q angle than that of males can be associated with pelvis of females which is much wider in comparison to males. The distance from the patella to the pelvis is longer than the distance from tibial tuberosity to patella, it can be derived that placement of the anterior superior iliac spine has a greater effect on the values observed Q angle[18]. Values of Q angle of males and females obtained in this study is higher than majority of the reported value. This implies young population of India are at greater risk of having abnormalities in the knee joint.

This study was also trying to determine whether there is any relation between the Q angle and the Intercondylar distance. From the Table-2, we noted that with the increase in Intercondylar distance there is decrease in quadriceps angle. The peculiarity of this study is that it was also trying to observe which parameter (Intercondylar distance / Quadricep angle) is the better predictor for Patellofemoral pain syndrome. From the values obtained after calculation of Cohen's kappa coefficient of both parameter and comparative analysis of the obtained level of agreement showed that, Q angle is a better predictor for Patellofemoral pain syndrome.

Conclusion

Statistically significant ($p<0.05$) asymmetry in Q angle was found on the basis of gender. Females had higher Q angle in comparison to males and making them more susceptible to disorders of patellofemoral joint. There was statistically significant ($p<0.05$) negative correlation between Q angle and Intercondylar distance, implying that with the increase in condylar distance there is decrease in Q angle. In addition, Cohen's Kappa coefficient of Q angle was 0.72 while that of Bi-condylar distance was 0.49. This showed, Q angle is a better predictor for Patellofemoral pain syndrome.

Outcome of this study will encourage not only to carry out periodic screening of susceptible population but also its usage in clinical practice and prognosis of affected individual after treatment. These findings will create awareness among coaches and managers of sportspersons as well as in overall female population.

Limitation

This study presents normative data and comparative statistics on the basis of gender and categorical variation. No follow up mechanism was in place for borderline or risk group (above par Q angle), so we couldn't indulge in cause and condition relationship between outcomes of data collected and patellofemoral disorders.

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