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Establishing A Normative Data of Quadriceps Angle in Sedentary and Sportsperson in North Indian Population: An Approach for Future Knee Pathologies

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Abstract

Background: Normal alignment of the lower extremity is important for mobility. Quadriceps angle (Q angle) reflects biomechanics and patho-mechanics of the knee joint. An increase of Q angle above the normal range increases the lateral vector pull on the patella and eventually potentiates into knee pathologies. The purpose of this study is to provide normative data of Q angle in sedentary and sportsperson in North Indian population. Moreover, an analytic overview between the categories based on gender was also done.

Subjects And Methods: This study composed of 130 healthy individuals which were divided into two categories: Sedentary people and Sportspersons. Each category consisted of 65 individuals (35 males and 30 females). Q angle (goniometric method) of each participant was calculated. A comparison of body parameters was done by independent t-test. P-value less than 0.05 was considered significant.

Results: Statistically significant ($p<0.05$) asymmetry was found in Q angle between sedentary and sportspersons. Gender differences in Q angle were also found to be significant. Females had a higher value of Q angle than their counterparts ($p<0.05$). In addition, both sportsperson males and females had lower values of Q angle than their sedentary counterparts.

Conclusion: Quadriceps femoris angle should be used to assess the biomechanical function of knee joint. Females in both categories: sedentary and sportsperson, had higher Q angle in comparison to males, making them more susceptible for the disorders of the patellofemoral joint. Q angle has negative relation with the strength of the quadriceps musculature. Q angle has far greater significance in sportspersons, especially females who are involved in different competitive sports and physical activities. Thus, it's 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 the affected individual after treatment.

Keywords – Goniometer, Knee joint, Knee pathologies, Q angle, Sedentary, Sportsperson

INTRODUCTION:

Knee pathologies have become a common problem in the young and sporting population in recent years.[1] Although it is usually seen in individuals participating in sports especially females and the young population, it can also occur in a sedentary population.[2] Indulging in any sports or physical activity has a positive impact, but there is also a great concern of knee injuries.[3] Patellar overload syndrome, Hyper-mobile Knee Joint, Patellofemoral instability and Dislocation of the patella are some of the commonly seen knee pathologies.[4]

A well-functioning healthy knee joint and postural alignment are important for optimal locomotive activity. In an ideal postural alignment, a kinematic balance between bones, muscles and articulation must be there. Assessment of posture is significant for diagnosis, treatment, follow-up and prognosis of any knee pathologies and injuries.[5]

Quadriceps angle (Q angle) is an acute angle at the knee joint that provides information about the alignment of quadriceps musculature relative to the bony components.[6] It is established between two lines at the frontal plane, one extending from the anterior superior iliac spine to the centre of patella and another from the tuberosity of the tibia to the centre of patella.[7]

The values of the Q angle as documented by researchers around the globe vary. Hence, there is still no consensus regarding the normal Q angle.[8] However, the accepted normal Q angle is between 12 to 20 degrees. Q angle of an individual is said to be abnormal if male and female have value higher than 15° and 20° respectively.[9]

Q angle reflects pathomechanics and biomechanics of the Knee joint.[10] It is referred to be excessive when the vector drawn on patella deviates laterally due to the pull by quadriceps femoris musculature. It will eventually lead to the speedy malfunction of the knee joint and knee pain resulting in Knee pathologies. Q angle increases in case of genu valgum, femoral anteversion, tight lateral retinaculum, laterally placed tibial tuberosity and external torsion of the tibia.[11]

Regarding the lifestyle of the Indian population, there is a far greater likelihood of crunching pressure on the knee joint in doing activities involving unusual flexion such as squatting or sitting crossed legs.[12]

The purpose of this study is to provide normative data of Q angle in sedentary and sportsperson in North Indian population. In addition, we have also tried to compare the Q angle between sedentary and sportsperson of both genders.

METHODS:

This was a cross-sectional study undertaken at Teerthanker Mahaveer University. The study sample comprised of two categories- sedentary people and sportspersons. A total of 130 individuals consisted of 35 males and 30 females of each category were selected by random sampling method.

Inclusion criteria:

- Age between 18 to 35 years[9]
- Palpable anterior superior iliac spine, patella and tibial tuberosity

Exclusion criteria:

- Any injury to lower limb that leads to ligamentous, muscular or bony defect
- Spinal or neurological injury
- Diagnoses of knee disorder like fracture
- Acute or chronic knee pain
- Dislocation of the patella.[10,11]

Measurements were done after securing approval from the Institutional Ethical Committee (Ref. No.- TMMC&RC/IEC/19-20/116) of 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 to undergoing study after noting their name, age, sex and region. Determination of a person, whether he/she a sportsperson or not was done according to the definition given by Maron BJ et al.[12] Q angle of each participant were calculated.

The goniometric method was adopted to calculate the Q angle. Firstly, participants were asked to be in a 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 concerning the surface. Three bony points; the Anterior Superior Iliac Spine (ASIS), the centre of Tibial Tuberosity (TT) and the Centre of Patella (CP) were identified and marked by a marker.

For identifying CP, the contour of the patella was drawn after appreciating the borders without stretching skin (Figures-1&2). The CP was referred to as 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.

The hinge of the goniometer (least count of the goniometer-1 degree) was placed at CP and the arm of the goniometer was arranged in such a way that one is positioned in the straight line drawn from ASIS to TT and another arm to the line from ASIS to CP. The acute angle formed between the two arms of the goniometer was recorded as Q angle.[3]

For statistical analysis, SPSS version 23 (IBM Corp., Armonk, NY) was used. The comparison of Q angle was done by independent t-test. The p value < 0.05 was considered statistically significant.

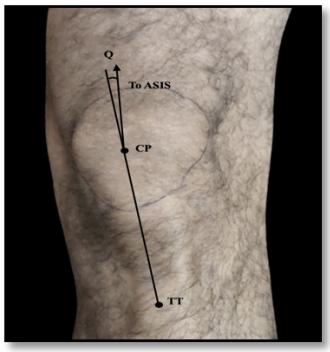

Figure-1: Measurement of Q-angle in right knee
Q- Quadriceps angle; ASIS- Anterior Superior Iliac Spine; CP- Centre of Patella; TT- Tibial Tuberosity

Figure-2: Measurement of Q-angle in left knee
Q- Quadriceps angle; ASIS- Anterior Superior Iliac Spine; CP- Centre of Patella; TT- Tibial Tuberosity

RESULT:

Table-1 shows the comparison of Q angle between sedentary people and sportspersons. The mean Q-angle in sedentary persons was observed to be 15.89° + 2.28°. The mean Q-angle in sports persons was 12.25° + 1.66°. Independent t-test revealed a statistically significant difference ($p<0.05$) in Q angle between sedentary people and sportspersons.

Table-2 compared the differences of Q angle within genders- Sedentary males vs Sportsperson males and Sedentary females vs Sportsperson females. The mean Q angle of sedentary males was 15.11° + 2.72°, while that of sportsperson males was 11.46° + 1.46°. In sedentary females the mean Q angle was 16.80° + 1.10° where as in sportsperson females was 13.17° + 1.40°. The results showed statistically significant differences ($p<0.05$) among males and females of both categories.

Table-3 showed the differences of Q angle based on gender in Sedentary and Sportspersons. In sedentary persons the mean Q angle was 15.11° + 2.72° and 16.80° + 1.10° in males and females respectively. The mean Q angle in sportspersons was 11.46° + 1.46° and 13.17° + 1.40° in males and females respectively. Paired t-test showed a statistically significant difference ($p<0.05$) in Q angle between males and females in both the categories, Sedentary and Sportsperson.

Table-1: Comparison of Q angle between sedentary people and sportspersons.

Parameter	Sedentary (Mean + S.D)	Sportsperson (Mean + S.D)	t-value	p-value
Q-angle(degree)	15.89 + 2.28	12.25 + 1.66	10.43	<0.05*

*p <0.05-Statistically significant variation in Q angle between sedentary people and sportspersons.

Table-2: Comparison of Q angle in Sedentary males vs Sportsperson males and Sedentary females vs Sportsperson females.

Category	Q angle (Mean + S.D)	t-value	P-value
Sedentary Male	15.11 + 2.72	7.00	<0.05*
Sportsperson Male	11.46 + 1.46		
Sedentary Female	16.80 + 1.10	11.24	<0.05*
Sportsperson Female	13.17 + 1.40		

*p <0.05-Statistically significant difference in Q angle in Sedentary male vs sportsperson female and sedentary female vs sportsperson female.

Table 3. Comparison of Q angle based on gender in Sedentary and Sportsperson.

Categories	Gender	Q angle ((Mean + S.D))	t-value	P-value
Sedentary	Male	15.11 + 2.72	3.18	<0.05*
	Female	16.80 + 1.10		
Sportsperson	Male	11.46 + 1.46	4.80	<0.05*
	Female	13.17 + 1.40		

*p <0.05-Statistically significant difference in Q angle between male and female in both the categories, Sedentary and Sportsperson

DISCUSSION:

It is an established medical fact that Q angle measures united vector draw of the extensor mechanism of knee and tendon of patella. It provides information relating to the movement of knee with contraction of thigh muscles and also tracks patellar movement in the groove of knee joint. Q angle is a significant index while determining the condition and functioning of knee joint along with knee alignment in the frontal plane.[13,14] If estimated correctly in manner, it gives decisive info about the positioning of the pelvis, thigh, leg and foot.[15,16] It has been recommended that unusual positioning causes a change in biomechanics which might affect loads on joints and the function of muscles.[17] In this study, the mean Q angle of sedentary people was found to be 15.89° + 2.28° and that of sportspersons was 12.25° + 1.66°. It was far greater than any study conducted in the Indian population. This implies, there is increased lateral vector pull of quadriceps muscles on the patella of the population of this region which can eventually potentiate into patellofemoral disorders like chondromalacia and dislocation of the patella. This will change the biomechanics of the knee joint and deteriorate its normal functioning.[13,18]

According to the study conducted by Omololu et al. and Jha et al., the average Q angle varied within the range of 8°-22.8°.[19,20] This variation can be attributed to ethnicity, gender, age and height. Moreover, while going through all the scientific literature, we observed a method employed to measure the Q angle can also bring in the variation.[21]

Comparison of Q angle between sedentary people and sportspersons was statistically significant. Research conducted by Elioz M et al., on Quadriceps angle in sedentary, amateur athlete and professional athlete was 10°, 9.01° and 8.72° respectively.[22] While Kishali NF et al., in their study observed an average Q angle of 13.25 ± 1.81° in male athletes and 17.28 ± 1.29° in female athletes, for the supine position. Q angle of a sportsperson was less than that of sedentary.[23] The strength and tone of the Quadriceps musculature determine the position of the patella and eventually the value of the Q angle. This variation may be due to the dynamic and intensive quadriceps training a sportsperson does daily. This training straightens the Q angle resulting lower values in Sportsperson. Hence, the majority of researchers suggest participating in physical activities and sports involving high lower limb activities. This would not only lower the Q angle but also decreases the possibility of future knee pathologies.[1]

From Tables 2 & 3, we noted that females had higher Q angles than males. The possible reasoning for the occurrence of higher Q angle in females can be associated with wider pelvic dimensions when compared to males. It results in the positioning of ASIS more laterally in females leading to increased distance of the pelvis to the CP than the distance from tibial tuberosity to the CP.[3] On the contrary to this explanation, Jaiyesimi AO et al. pointed out that variation in the values is associated with the height of an individual rather than the placement of bony landmarks i.e., since male participants tend to have a greater height than that of females, Q angle in males is lower in comparison to females.[24,25] Higher Q angle in females increases the compression of articulating areas and makes them more susceptible to future knee pathologies.[1]

CONCLUSION:

The average Q angle of sedentary was 15.89 + 2.28° and that of a sportsperson was 12.25 + 1.66° in the Indian population. Hence, Upper limit for Q angle for sedentary is 18.17° and that of sportsperson is 13.91°. Sportsperson had a lower Q angle than sedentary, suggesting Q angle has negative relation with the strength of the quadriceps

musculature. Dynamic and intensive quadriceps training of sportsperson tends to increase the quadriceps strength and decrease the Q angle. The sedentary population especially females have lower quadriceps strength and higher Q angles making them more prone to knee pathologies.

Performance of lower extremity is extremely important in physical activity. It has greater significance to sportspersons, in particular females, who are involved in different competitive sports and physical activities. The outcome of this study will encourage not only to carry out periodic screening of susceptible populations but also its usage in clinical practice and prognosis of affected individuals after treatment. Different correctional exercises can be started as a precaution to prevent future disorders. In individuals going through rehabilitation programs, a periodic checkup of the Q angle will provide vital info in evaluating the strategy of treatment and modifying it, if necessary. These findings will create awareness among coaches and managers of sportspersons as well as in the overall female population.

LIMITATION:

Our study was a cross-sectional one so we didn't conduct follow up on participants having borderline or above par Q angle. This prevented us to find out the cause-and-effect relationship between abnormal Q angle and knee pathologies.

Authors Contribution: Dr. Saurabh Chaudhary conceptualized the study and wrote the paper. Ms. Aleeza Muneer contributed for data collection. Dr. Supriti Bhatnagar provided statistical expertise, performed the statistical analysis. Dr. Dhananjay Kumar provided critical review of the analysis and manuscript.

Conflicts of interest: No conflicts of interest

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