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Original research article

Variation in quadriceps angle (Q angle) and its correlation with anthropometric parameters

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Abstract

The knee joint is a unique condylar synovial joint that is supported by ligaments and muscles. About 50% of musculoskeletal problems involve it. The quadriceps femoris muscle's resultant force, which has its apex at the patella, forms a line with the ligamentum patellae, creating the Q angle, has a vital role to play in several knee pain, disorders, injuries, rehabilitation as well as sports. There are several variations noticed in this angle in the literature and more literature needs to be established on Indian population.

Aims and objectives: To Identify variation in the Q angle values in both genders and to assess the correlation with the other anthropometric measures.

Methodology: Following the assessment of the other anthropometric measures, the Q angle measurement was conducted while the participant was in a supine position.

Results and Conclusion: The findings suggests that the mean Q angle of the right and left lower extremities in the adult male population was different than those of the female group. Also, the other Anthropometric measures were correlated with the Q angle in the study.

Keywords: Q angle, Waist Circumference (WC), Hip circumference (HC), pelvis width, Height, Weight, BMI

Introduction

The knee joint is a multifaceted synovial joint categorized as condylar, which is upheld by ligaments and muscles for stability which are prone to musculoskeletal issues as observed in around 50% of cases [1]. The measurement of the quadriceps angle (Q angle) holds significant value in evaluating the mechanics of the patellofemoral joint, making it a subject of considerable interest among physiotherapy community. The examination consists of a quantitative analysis of the pelvis, femur, and tibia to determine how well they are aligned with respect to the quadriceps femoris muscles [2]. It was first defined by Brattstroem [3] as “an angle formed between the ligamentum Patellae and the extension of the line formed by the quadriceps femoris muscle resultant force with its apex at the patella”. Later, Insall cites James (2003) discussing the assessment methodology of measuring the Q angle, concluded that a value over a threshold value of 15 degrees for males and 20 degrees for females, was considered abnormal [4].

For many subjects presenting with Patellofemoral discomfort, the Q-angle is frequently employed, along with many other commonly utilized clinical bedside assessments such as the patellar glide test and J-sign, to ascertain the underlying reasons contributing to it and that may have led to an angle that exceeded or caused quadriceps activation in a direction that could result in an imbalanced lateral displacement of the patella during dynamic activities [4-6]. This could be a combination of forces acting on the knee cap commonly referred to as "patellar maltracking", which eventually contributes to the occurrence of Patello-Femoral pain syndrome and other instabilities. Consequently, the Q angle has been widely acknowledged as a significant determinant in evaluating knee joint functionality and also there is considerable disagreement around the underlying cause of the greater Q angles observed in females and its variations in Indian populations [5-9].

There is a scarcity of academic research regarding b shifts in the Q angle on the left and right, with a majority of existing studies mostly focusing on intergroup disparities rather than intra subject [10, 11]. This

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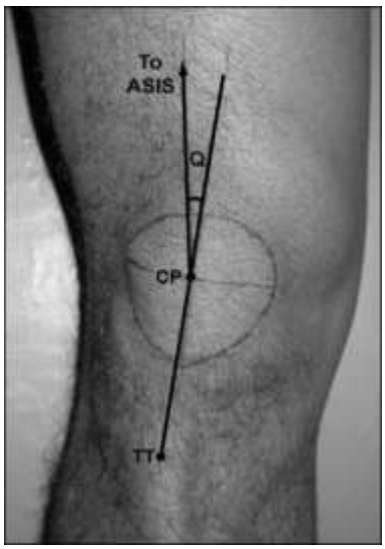
research set out to record the differences in average Q angle between the two eyes and to examine the link between various anthropometric measurements in relation to the aforementioned findings among young adult males and females in the Indian population of Delhi.

Methodology

This cross-sectional observational study was initiated on 100 consenting subjects recruited from colleges/universities in Delhi of 18-25 years of age and with no previous musculoskeletal abnormality induced by past history of hip, knee injury and/or surgery or fracture of lower limb, any congenital disorders, limb length discrepancy, spinal deformity, flat foot and also females with a history of wearing high heels regularly. Procedure: Ethical clearance for the study was obtained from the Institution. Participants were given detailed explanations of the technique and asked to sign a permission form before it began. History was taken and assess the subjects for exclusion criteria. A total of 200 lower extremities (100 individuals made up of 50 men and 50 woman's) were assessed.

Then the individuals were examined for their anthropometric measurements like weight, height, waist and hip circumference. The measurement of waist circumference was conducted while the participant was in an upright position, with the measurement taken at the midpoint between the lower rib margin and the iliac crest, with a rigid measuring tape whereas the hip circumference was conducted in the same position at the widest point of the hip bone at the level over the buttocks. For the quadriceps angle, the researchers in this study implemented a goniometric technique as outlined by Jha and Raza [9]. As stated below. Maintaining the pelvic alignment, the Q angle was measured while the individual was in a supine position with knees in extension, enabling the quadriceps muscle in a state of relaxation. The hips were positioned in a state of neutral rotation, with the toes oriented vertically upwards and the feet forming a 90-degree angle with the surface on which they were put. The bony landmarks, namely the "anterior superior iliac spine (ASIS)", the "pubic symphysis (CP)" and the "center of the tibial tuberosity (TT)" and contour of the patella were identified and delineated using a marker pen and then the lateral and medial patellar girths at their widest points.

After finding the highest point, we used the straight edge of a measuring tape to draw a line from the central point (CP) to the anterior superior iliac spine (ASIS), which also served to link the CP to the point in the center of the TT. The observation was made and data was recorded by the vertical elongation of the later line that was made, with the help of a goniometer, measuring its angle with the earlier line that went towards the ASIS. Data was noted and subjects was thanked for participation.



Results

A Total of 100 participants were included in the study as per the inclusion criteria. 10 subjects refused to participate and 32 subjects were not assessed as they differed in dominance or demonstrated slight LLD or flat foot. A total of 58 subjects were finally assessed. Table 1 displays the demographic information for all participants.

Table 1: Demographic Subjects Recruited in the Study

Anthropometric measure	Male (N=28) (Mean± SD)	Female (N=30) (Mean ± SD)
Age	21.32 ± 1.61	20.63 ± 1.31
Weight	171.64 ± 6.90	158.11 ± 5.89
Height	65.32 ± 7.72	51.74 ± 6.09
BMI	21.93 ± 1.96	20.61 ± 2.00

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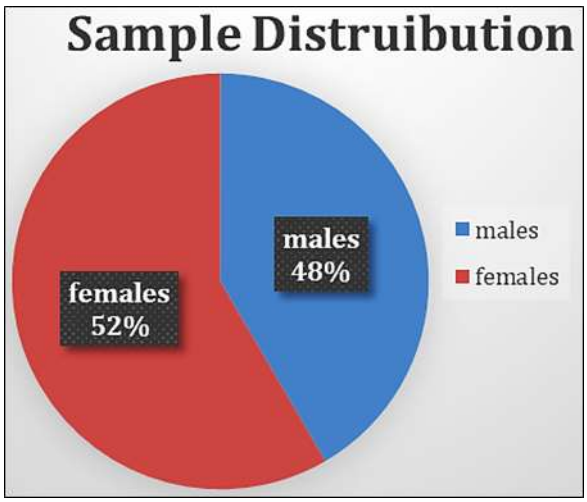
Pelvis Width	23.79 ± 1.99	22.86 ± 2.09
Waist Circumference	84.32 ± 7.38	76.23 ± 8.52
Hip Circumference	95.39 ± 7.61	93.74 ± 7.11



Graph 1: Gender wise Distribution

Q angle was measured for the left and right leg for both males and females and bilateral variability was assessed using t-test after establishing the normality of the data. All analyses were performed on IBM SPSS statistics software and a p value < 0.05 was deemed significant. Levene's test of Equality was established at baseline. The result of this study establishes highly significant correlation between the left and the right Q angles and the average Q-angle for the right and left lower limb in the adult male population was 16.82 ± 1.98° and 15.64 ± 1.74° respectively while that for the female group had their Right QA and Left QA as 18.87 ± 2.98° and 17.07 ± 2.72° respectively. The Right QA was significantly higher than the Left QA (p<0.001). The average lateral positioning of the tracheal tube (TT) was found to be substantially higher on the right side. When comparing the right and left sides of the body using a paired comparison, we found that the Q angle and the lateral placement of the tibial tubercle (TT) varied significantly.

Table 2: Gender wise Bilateral Q angle

Gender	**Q Angle**		**Statistical measure**
	Left Leg (in degrees) MEAN ± SD	**Right Leg (in degrees) MEAN ± SD**	**p-value**
Male	15.64 ± 1.74	16.82 ± 1.98	p<0.01
Female	17.07 ± 2.72	18.87 ± 2.98	p<0.01
p-value	0.022	0.003	

Non parametric Spearman's Correlation test was used to analyze the correlation between the left and the right side of Q angle, between the Gender and Right Q angle which was found to be Spearman Rho= 0.335 (p=0.010) and that for Left Q angle Spearman Rho= 0.261 (p=0.047), Q angle on right and left individually with the Height, weight, BMI, Pelvis Width, Waist Circumference and Hip Circumference. A highly Significant and strong correlation was found between the measures of Q angle on the left and right side. There was also significance between the gender and Q angle however was found to be very low. However, there was no significant correlation was found with the other parameters as depicted in the table 3.

Table 3: Spearman Correlation matrix for the parameters

	Left Q angle	**Height**	**Weight**	**BMI**	**Waist Circum**	**Hip Circum**	**Pelvis Width**
Right Q Angle	p<0.001	0.298	0.333	0.960	0.182	0.948	0.226
Spearman's Rho	.891**	-0.139	-0.129	-0.007	-0.178	0.009	0.161
Left Q Angle	1.000	0.469	0.539	0.979	0.538	0.844	**0.049**
Spearman's Rho		-0.097	-0.082	-0.004	-0.082	0.026	0.259*

**Significant Correlation at 0.01 level.
*Significant Correlation at 0.05 level.

Discussion

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The Q angle has been studied globally, but few have examined its bilateral variability in Indian populations. All research participants were demographically examined at baseline. As seen in our data, female and male left and right Q angles differed significantly.

Maharjan R, *et al*. (2013) determined a reference value for 1200 subjects from different locations in eastern Nepal for their normal Q-angles and correlated it with other anthropometric factors including the age, height, weight and arm span and measured it in different positions. Weight shows a substantial link with Q angle in males, but not in females. They found Q angle asymmetry within subjects, positions, and genders. Thus, they suggested that both sides should be measured for Q angle [12].

In a study authored by TimoByl, Jennifer A. Cole, and Lori A. Livingston (2010), the investigators examined the bilateral measurement of the Q angle in relation to chosen skeletal and muscular strength measurements to determine an inverse relationship between the magnitude of the Q angle and quadriceps strength [13]. Veeramani *et al*., (2009) conducted a study aimed at evaluating a geometric method for analyzing the positions of the center of the patella and the tibial tuberosity utilized trigonometric analysis to accurately determine the relative positions of these anatomical landmarks in relation to the medial and lateral joint lines [14]. Dhaher YY, Kahn LE (2002) found that flat foot deformity may increase Q angle in secondary school children [15]. The Q-angle is formed by the vectors from the anterior superior iliac spine (ASIS) to the patella (knee cap) and from the patella to the tibial tuberosity. Quadriceps muscles and patella tendon are represented by the first and second vectors, respectively [2, 16]. Thus skeletal measures and variability may affect the quadriceps angle.

Also, our study depicts Females had greater Right QA than the Left Q-angle and also depicted greater variability. This matches the results of that of Woodland [10, 17] to estimate normal, mean quadriceps angles (Q angles) in sports and different postures respectively. Though subjects assessed by Livingston Akibo and Mandigo [16] reported higher LQA, women consistently have more expansive Q angles and more patellofemoral issues than males may present with increased skeletal measures like pelvic breadth, shorter femur length, or femoral neck anterversion. However, the present investigation found no association with pelvis width. A greater Q-angle (15 degree for men and 20 degree for women) may additionally put subjects to at a mechanical disadvantage, when muscles are engaged, with respect to the orientation of the patellar ligament's alignment placing additional vectorial forces which may further aggravate the Q angle. Thus, quadriceps activation and triggering during activities may predict susceptibility to knee injury during athletics requiring leaping and landing.

Lathinghouse and Trimble proposed that an elevated Q-angle in women may put them to a potential risk of experiencing lateral displacement of the patella while engaging in activities that demand high levels of quadriceps engagement [18].

Jaiyesimi and Jegede (2009) found that male Q-angles were 12.30° +4.0° and 10.38° +3.49° for the right and left lower limbs, whereas female Q-angles were 17.06° +3.64° and 14.84° +3.47°. Authors have observed no association between gender and Q angle with respect to the height if it is considered during data analysis. All authors have suggested bilateral data collection due to significant variations in lower extremity length and differences in measures of patella and the muscle attachments to it [5, 9, 19].

Conclusion

From this study it is deduced that the Q angles, both right and left, exhibit inequality within the same individual and are comparatively greater in women. The existing literature implies that these variances may be associated with disparities in quadriceps muscle strength. Future studies may be suggested in this direction with a larger sample size.

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