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Influence of gender and bilateral variability of the quadriceps angle (Q angle) among adults

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Abstract

Objective: The objective of study aimed to document bilateral variability in the mean Q angle and to study whether there is any difference of the above findings in males and females.

Materials and Methods: One hundred healthy adult volunteers were studied. The Q angle was measured using a goniometric method with the subjects supine, quadriceps relaxed and lower limbs in neutral rotation. Appropriate statistical tests were used to determine the bilateral variability in the Q angle.

Results: Of the 100 subjects included in the study mean age observed was 30.63+/-6.89 and mean Q angle of 16.20+/-4.45 and 15.12+/-4.34 on right and left side respectively. On comparing the Q angle between the right and left side of same sex, and between either sex was found statistically insignificant.

Conclusion: The present study may not have any direct clinical applications, it is likely to be useful in explaining differences in the Q angle on either side of both sexes.

Keywords: bilateral variability, goniometer, Q angle

Introduction

The quadriceps angle or Q angle, is the angle formed by the encounter of two lines, one that starts at the anterior superior iliac spine (ASIS) and goes to the center of the patella (CP) and another that goes from the tibial tuberosity (TT) to the center of the patella [1-7] It is a clinical measurement used to measure knee alignment with respect to the hip, femur and tibia and to evaluate the patella alignment [5, 8].

The Q-angle was initially described by Brattstrom [9] It is an index of the vector for the combined pull of the extensor mechanisms and the patellar tendon and as a reflection of the force of the quadriceps muscle on the patella in the frontal plane [10, 11] Traditionally, the Q-angle has been measured with subjects in supine, knee extended and with the quadriceps muscle relaxed. This is regarded as the 'traditional' or 'conventional' method of assessing Q-angle [12]. The American Orthopaedic Association considers 10° to be normal and 15° to 20° to be abnormal [13]. Some authors consider a Q-angle greater than 15° men and 20° for women abnormal [14] Studies have consistently shown women have a greater Q-angle than men [15-18]. The reasons postulated for this observation are the widely spaced hips among women, the short length of the femur, or a combination of both [19, 20]. The Q angle has come to be accepted as an important factor in assessing knee joint function [21].

An increase in Q angle beyond the normal range is considered as indicative of extensor mechanism misalignment and has been associated with patellofemoral pain syndrome, knee joint hypermobility and patellar instability [22-24]. Moreover, its role in assessing other lower extremity injuries in sports and military populations has been documented [21].

Though bilateral differences in the Q angle have been documented, most studies done so far have concentrated on between-group rather than within-subject differences [25-28] Moderate to substantial amounts of bilateral asymmetry in the Q angle values when analyzed on an individual basis has been demonstrated [25, 29]. This has been attributed to bilateral asymmetry in the quadriceps muscle strength [29]. However, within subject bilateral differences in the relative position of the CP and TT, which are likely to alter the value of the Q angle. Hence the present study aimed to document bilateral differences in the mean Q angle and to study whether there is any difference of the above findings in males and females.

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Material and Methods

- This study was conducted in outpatient department of Orthopedics at Mandya Institute of Medical Sciences, Mandya, Karnataka for a period of 2 months from September and October 2017. The inclusion criteria were age group from 18 to 45 years of either sex with 50 members in each group.
 - Individuals with the following history were excluded from the study.
 - History of fracture of the lower limb, chronic knee pain, dislocation of the patella and spinal cord pathology with lower limb involvement.
 - Anterior or retro-patellar pain when performing at least two of the following activities: ascending stairs, being seated for long periods, upon squatting, kneeling or jumping.
 - Any history of surgery on the knee, clinical evidence of meniscal injury, ligamentous instability and patellar tendinitis.
 - Individuals with any congenital condition of lower limb.
- Based on the above mentioned criteria patients were included in the study after taking informed written consent. The patients participating in the study were evaluated by history and clinical examination.

Method of data collection

Measurement of the Q angle

A goniometric method as described by Jha and Raza was adopted [30]. The measurement of the Q angle was performed with the subject supine and keeping the pelvis square. The legs were extended at the knee joint with the quadriceps muscle relaxed. 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. The following bony landmarks were marked with a marker pen: ASIS, CP and centre of the TT. The outline of the patella was drawn with a marker pen, after palpating the borders and making sure that the skin was not stretched in doing so. The CP was defined as the point of intersection of the maximum vertical and transverse diameters of the patella. The point of maximum prominence was defined as the centre of the TT. One line was drawn from the CP towards the ASIS using the straight edge of a measuring tape and represented the longitudinal axis of the femur. Another line joined the centre of the TT and the CP. The second line was extended upwards. The angle formed between the above two lines was defined as the Q angle and measured with a goniometer. Appropriate statistical tests were used to analyze the data.

Results

Of the 100 subjects included in the study mean age observed was 30.63 \pm 6.89 and mean Q angle of 16.20 \pm 4.45 and 15.12 \pm 4.34 on right and left side respectively. With 50 subjects each in both group, mean age was 28.54 \pm 6.84 and 32.72 \pm 6.36 in male and female group respectively.

The mean Q angle on right side was 15.60 \pm 4.56 in male and 16.80 \pm 4.23 in female and on left side it was 14.04 \pm 4.25 in male and 16.20 \pm 4.20 in female. In both male's and female's there was no statistical significant difference observed on either right or left side (Table 1).

On comparing the Q angle between the right and left side of same sex, mean Q angle on right side is 15.60 \pm 4.56 and on left side is 14.04 \pm 4.25 in male's, in female's it is 16.80 \pm 4.23 on right side and 16.20 \pm 4.20 left side, both which found statistically insignificant (Table 2).

Table 1: Comparison of Q angle between male and female

	Male	Female	P-Value
Right	15.60 \pm 4.56	16.80 \pm 4.23	0.179
Left	14.04 \pm 4.25	16.20 \pm 4.20	0.012

Table 2: Comparison of Q angle between right and left side

	Right	Left	P-Value
Males	15.60 \pm 4.56	14.04 \pm 4.25	0.080
Females	16.80 \pm 4.23	16.20 \pm 4.20	0.482

Discussion

The Q-angle has been implicated as one of several factors in various knee disorders. It is a relevant clinical measurement because abnormally high Q-angle is one of the main cause of anterior knee pain and patellofemoral instability. Minor bilateral variations of bodily structures are a rule rather than an exception. However, significant differences warrant closer scrutiny. Hahn and Foldspang were among the first investigators to make a detailed study of the bilateral variability in the Q angle [31]. Following this, other studies have documented similar bilateral variations [25, 27-29]. In some of these studies it was found that the mean Q angle on the right side was greater than that on the left [31, 27, 29]. In other studies the mean Q angle was more on the left as compared to the right [26, 28]. In the present study the mean Q angle greater on the right side and in females as compared to the left side and males but this difference was not statistically significant. Study by Raveendranath V *et al.* [32] to measure Q angle among two hundred limbs of healthy adult Indian volunteers shows the mean value of all the 200 limbs was 12.73 $^{\circ}$, the mean value on the right was 12.86 $^{\circ}$ and 12.60 $^{\circ}$ on the left. Livingston and Mandigo [33] reported asymmetry, with the differences ranging from 0.9 $^{\circ}$ in men and 1.7 $^{\circ}$ in women. Study by Jaiyesimi A O *et al.*, [34] showed that in the male subjects, the Q-angles were 12.30 \pm 4.0 and 10.38 \pm 3.49 for the right and left lower limbs respectively, while in the female subjects, the Q-angles were 17.06 \pm 3.64 and 14.84 \pm 3.47 for the right and left lower limbs respectively. Analysis revealed a significant contra-lateral difference. Generally, the right Q-angle was significantly higher than the left ($p < 0.05$) in both the male and female subjects. The females had significantly higher Q-angles than their male counterparts ($p < 0.05$). The accurate determination of the Q angle requires precise identification of the three bony landmarks used to measure it. France and Nester found that even small differences in the placement of the CP and TT could alter the Q angle greatly [35]. There is a subjective element in determining the CP as it depends on marking of the intersection of the greatest transverse and vertical diameters. Also, the centre of the TT cannot be determined precisely in some subjects. In these subjects the TT is a plateau atop an elevation. Thus, the findings in the present study need to be validated using more accurate methods, such as those described by Roush *et al.* [36]. Some authors have questioned the reliability and validity of the Q angle in evaluating and treating patello-femoral joint pathology [37-39]. Smith *et al* in a systematic review of the literature found that there is a lack of standardization in the measurement procedure of the Q angle [40]. Thus, bilateral variability of the Q angle could be influenced by the procedure used to measure it.

Conclusion

The present study demonstrates bilateral variability of Q angle in healthy adults. Mean Q angle measurements was more on the right side and in females when both sexes were considered

together though it was not significant. The present study may not have any direct clinical applications, it is likely to be useful in explaining differences in the Q angle on either side of both sexes.

Conflicts of interest: Nil

Source of funding: Nil

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