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Morphometric Study of Quadriceps Angle and Its Correlation with Gender

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Abstract

Introduction: The **quadriceps angle (Q-angle)** is a clinically significant anatomical parameter representing the line of pull of the quadriceps femoris muscle relative to the patellar tendon and reflects lower limb alignment and patellofemoral joint biomechanics. Variations in Q-angle have been associated with anterior knee pain, patellar instability, altered gait mechanics, and increased risk of sports-related injuries.

Aim and Objective: The present study aimed to evaluate the morphometric values of Q-angle in healthy young adults and to assess its correlation with gender differences.

Material and Method: A cross-sectional observational study was conducted on 86 healthy volunteers (43 males and 43 females) aged 18–25 years. Bilateral Q-angle measurements were obtained in the supine position using a standard universal goniometer, ensuring relaxed quadriceps muscles.

Result: The mean Q-angle values were calculated and statistically analyzed to determine gender-based variations. The results demonstrated that females exhibited slightly higher mean Q-angle values compared to males on both right and left sides; however, the difference was not statistically significant. Bilateral symmetry of Q-angle was observed in both genders.

Discussion: The findings support the concept that **pelvic morphology, femoral alignment, and biomechanical factors** influence Q-angle values, though gender alone may not be a strong independent predictor in young asymptomatic adults.

Conclusion: The study provides valuable baseline morphometric data for the Indian population and emphasizes the relevance of Q-angle assessment in clinical anatomy, orthopedics, sports medicine, and rehabilitation practice. Understanding normal Q-angle variations is essential for accurate diagnosis of patellofemoral disorders and for planning preventive and therapeutic interventions related to knee joint biomechanics.

Keywords: Quadriceps angle; Pelvic width; Knee alignment; Patellofemoral joint

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Introduction

The **quadriceps angle (Q-angle)** is defined as the acute angle formed between a line drawn from the anterior superior iliac spine to the center of the patella and another line extending from the center of the patella to the tibial tuberosity. It represents the resultant vector of quadriceps muscle force acting on the patella and plays a pivotal role in maintaining patellofemoral joint stability. Since its first description by Brattström, the Q-angle has been widely used as an important anatomical and biomechanical parameter in the evaluation of knee alignment and function (1, 2025). Abnormal Q-angle values have been implicated in patellar maltracking, anterior knee pain syndrome, chondromalacia patellae, and increased susceptibility to knee injuries, particularly among athletes (2, 2025). Gender-based differences in Q-angle have been frequently reported, with females generally demonstrating higher values than males. This variation has been attributed to factors such as wider pelvic breadth, increased femoral anteversion, shorter femoral length, and valgus knee alignment commonly observed in females (3, 2025). However, literature shows inconsistency regarding the magnitude and clinical relevance of these differences, with some studies reporting statistically significant variations while others demonstrate minimal or no gender influence (4, 2025). Accurate measurement of Q-angle is influenced by several factors including body posture, muscle contraction, limb position, and measurement technique. Studies have shown that Q-angle measured in standing position tends to be higher than in supine position due to weight-bearing and muscle activation effects (5, 2025). Despite these variations, Q-angle remains a widely accepted clinical tool for screening knee alignment abnormalities and guiding therapeutic decision-making. Understanding normal morphometric values of Q-angle in specific populations is essential for clinical diagnosis, orthopedic evaluation, and sports medicine applications. Population-specific data help establish reference values and improve interpretation of abnormal findings. The present study was therefore undertaken to assess the morphometric characteristics of Q-angle in young adults and to evaluate its correlation with gender in an Indian population, thereby contributing to anatomical, biomechanical, and clinical knowledge (6–9, 2025).

Materials and Methods:

A cross-sectional observational study was conducted in the **Department of Anatomy, Rama University, Kanpur**, after obtaining approval from the Institutional Ethics Committee. The study included 86 healthy adult volunteers comprising 43 males and 43 females aged between 18 and 25 years. Participants with a history of knee trauma, surgery, congenital deformities, neurological disorders, or lower limb fractures were excluded. Q-angle measurements were obtained bilaterally in the supine position with the quadriceps muscles relaxed. A standard universal goniometer was used, with anatomical landmarks carefully identified and marked. Each measurement was recorded twice and the mean value was considered for analysis. Data were entered in Microsoft Excel and analyzed using Jamovi 2.7.14 software. Independent t-test was applied to compare gender differences, and a p-value <0.05 was considered statistically significant (10–12, 2025).

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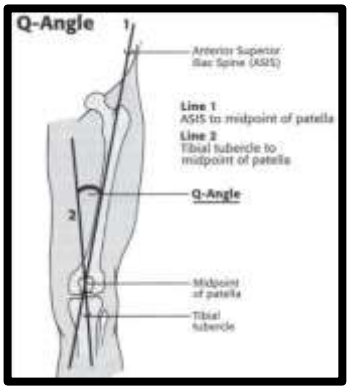

Photograpgh no. 1 showing Q angle measurement

Results:

The mean right Q-angle in males was 10.86° ± 3.52°, while in females it was 11.16° ± 3.50°. The mean left Q-angle was 10.65° ± 3.53° in males and 10.86° ± 3.62° in females. Although females demonstrated marginally higher values, the difference was not statistically significant ($p>0.05$). Bilateral symmetry of Q-angle was observed in both genders. Graphical representation of gender-wise and side-wise distribution of Q-angle values was prepared using Microsoft Excel to aid visual interpretation.

Table – 1: variation of Q angle (mean ± SD) with respect to gender

Gender	Right Q-angle (Mean ± SD)	Left Q-angle (Mean ± SD)	p-value
Male	10.86 ± 3.522	10.651 + 3.531	0.794
Female	11.162 ± 3.497	10.86 + 3.622	0.669
p-value	0.691	0.787	

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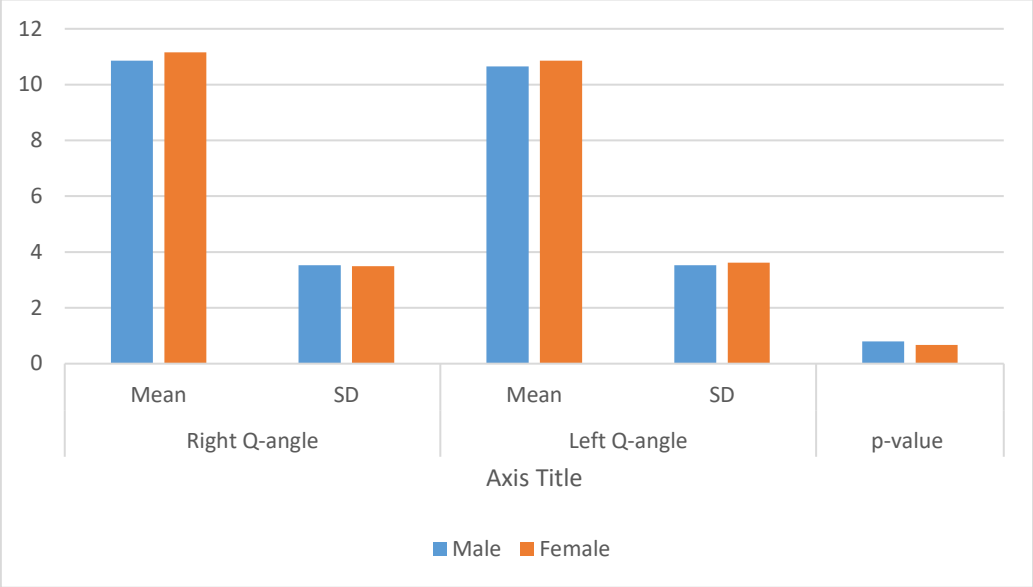

Figure- no. 1 showing the parameters of Q-angle with respect to gender (using MS Excel)

Discussion:

The present study demonstrates that females tend to have slightly higher Q-angle values than males, consistent with previously reported anatomical and biomechanical explanations. However, the absence of statistically significant gender difference suggests that factors beyond gender, such as individual pelvic structure and lower limb alignment, play a substantial role. Bilateral symmetry observed supports the concept of stable lower limb alignment in healthy individuals. These findings align with earlier studies that emphasize variability of Q-angle across populations and measurement conditions (6–9, 2025).

Conclusion:

The study concludes that while females exhibit marginally higher Q-angle values, gender alone does not significantly influence Q-angle in young healthy adults. The findings provide baseline morphometric data relevant to **clinical anatomy, orthopedics, sports medicine, and physiotherapy**, aiding in assessment of knee joint biomechanics and patellofemoral disorders.

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