

A study of Comparison of Quadriceps Angle (Q-angle) in Indian and East African Adults

Rai Anju L.¹, T. Kalyani², Awasthi Supriya³

Abstract

Q-angle is indicator of force produced by quadriceps and is a clinical tool to measure the knee function and alignment. It is well established that normal reference value of Q-angle varies in different racial groups like Caucasians, Americans, Asians and Africans owing to different anatomical and biomechanical features of knee joint complex. However, there is dearth of literature comparing values of Q-angle between Indian and East African population. *Objective:* (1) establish a baseline reference value of Q-angle among asymptomatic adults belonging to eastern Africa; and (2) To compare these values with their Indian counterparts. *Materials and Methods:* The study was done in Anatomy department on 100 students of Sharda University, Greater Noida. Bilateral Q-angle was measured with subjects standing in an erect, weight-bearing position. The subjects were divided into two groups (n=50 each group) Group-I (Indian) and Group-II (East African). Group-II subjects belonged to Kenya (n=23) and Tanzania (n=27). Bilateral asymmetry and gender variation was determined using appropriate statistical method. *Result and Conclusion:* In Group-I and in Group-II, the mean Q-angles values of 100 limbs were $13.78^{\circ} \pm 2.41$ and $17.06^{\circ} \pm 3.73$ the values were significantly higher in latter group ($p < 0.001$). Both the groups showed significant bilateral asymmetry ($p < 0.05$) and gender variation with Q-angle values being greater for women than in men ($p < 0.001$).

Keywords: Q-Angle; Bilateral Symmetry; Patellofemoral Alignment.

Introduction

Anatomical variability has been noted among various racial groups, particularly the African and Caucasians who have shown distinctive differences in their skull and pelvic anatomy.

A Caucasoid cranium is longer in height with round saggital contour and they have narrow nose while Negroid cranium has lower height with flat saggital contour and a broad nose [1].

White American women have a wide transverse diameter of pelvic inlet as well as of outlet, and thin pelvic diaphragm musculature as compared to Afro-American women [2,3].

Author's Affiliation: ¹Assistant Professor, Department of Anatomy, PGIMER, Dr. RML Hospital, New Delhi-110001, India. ²Lecturer, Department of Anatomy ³Assistant Professor, Department of Physiotherapy, School of Medical Sciences and Research, Sharda University, Greater Noida, Uttar Pradesh 201306, India.

Corresponding Author: Rai Anju L., Assistant professor, Department of Anatomy, PGIMER, Dr. RML Hospital, New Delhi-110001, India.

E-mail: anjulata72@gmail.com

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Earlier studies have also documented difference in values of Q-angle in the above mentioned races [4-7]. Q-angle is a useful parameter to evaluate effect of the quadriceps mechanism on the patellofemoral joint and also gives information concerning the alignment of the lower limb [8-11]. It is formed by the crossing of two imaginary lines, the first line extends from the anterior superior iliac spine (ASIS) to the centre of the patella (CP) and the second line is drawn from the tibial tuberosity (TT) to the CP. The American Orthopaedic Association considers the Q-angle value of 10° to be normal and $15-20^{\circ}$ to be abnormal [13] but, in one of the study values between $8-10^{\circ}$ for men and up to 15° for women were considered normal and values higher than these indicated patellofemoral joint pathology [14]. The inability to reach a definitive value for the Q-angle can be ascribed to methodological differences in measurement and bilateral symmetry or asymmetry. The angle is clinically relevant because of the pull it exerts on the patella. Higher Q-angle value increases the lateral pull of the quadriceps muscle on the patella, hence makes the individual prone to its recurrent lateral subluxation or chondromalacia patellae [4]. A lot of studies have been carried out to establish different values for Q-angles in men and women among the

Caucasians, Americans, and Africans, however there is dearth of literature comparing values between Indian and East African population. Hence this study was undertaken to (1) establish a baseline reference value of Q-angle among asymptomatic adults belonging to eastern Africa; and (2) To compare these values with their Indian counterparts.

Materials and Methods

To carry out this study, we selected 100 subjects using convenience sampling method from various schools of Sharda University. The subjects were asymptomatic adults (students) of age group 18-25yrs, with the mean age of the subjects was 19 years. They had no history of lower limb, spinal or neurological injury and any appreciable leg length discrepancy. The subjects were divided into two groups (n=50 each group) Group-I (Indian) and Group-II (East African). Group-II subjects belonged to Kenya (n=23) and Tanzania (n=27). All subjects were informed about the purpose of the study and signed consent was obtained. Ethical clearance for the study was obtained from the Institutional Ethical Review committee. We recorded the age and gender of each subject and gave instructions regarding positioning for measurement.

Q-angle was measured bilaterally in each subject in standing position the feet are placed together touching medially (with feet parallel), on the floor. ASIS, The centre point of the patella (CP) and tibial tubercle was palpated and then marked with a water soluble marker. The pivot of the Universal goniometer was placed on the midpoint of patella and a string was stretched between the ASIS and midpoint of patella to ensure accurate alignment of stationary arm of goniometer. The movable arm was aligned along

the line joining the tibial tubercle to midpoint of patella. The angle thus formed between the two arms of goniometer was measured and recorded as Q-angle.

Statistical Analysis

The mean and standard deviation were determined for age, and Q-angle in the two groups. Gender difference in above mentioned parameters and also bilateral differences in Q-angle were tabulated. The independent t-test was used to compare the Q-angle values in the male and female groups. The paired t-test was used to test for bilateral asymmetry.

All statistical analysis was performed using SPSS version 21.0 for windows.

Results

In Group- I and in Group- II, the mean Q-angles values of 100 limbs were $13.78^{\circ} \pm 2.41$ and $17.06^{\circ} \pm 3.73$. East African subjects had significantly higher value ($p < 0.0001$) than the Indian subjects the descriptive analysis of Q-angle for Group-I and Group-II subjects are shown in Table 1 and Table 2.

The study established that in both the groups Q-angle values for males was between 10° - 15° and none of our male subjects in either group had values of $\geq 20^{\circ}$. The Q-angle in adult Indian females was between 14° - 22° and for African females it was 16° - 24° . 11.5% of the female subjects in Group- I and 58% percent in Group-II had Q angles $> 20^{\circ}$. The mean Q-angles values in both the groups showed significant bilateral asymmetry ($p < 0.05$) and gender variation (Table 1 & 2) with Q-angle values being greater for women than in men ($p < 0.0001$).

Table 1: Mean Q- angle values in Group- I subjects

Parameter	Male (n=22)	Female (n=28)	p- value
Right knee	12.45 \pm 1.22	17.64 \pm 1.87	<0.0001*
Left knee	11.77 \pm 0.92	16.46 \pm 1.71	<0.0001*

* Indicates significant gender difference (using Independent t-test)

Table 2: Mean Q- angle values in Group -II subjects

Parameter	Male (n=26)	Female (n=24)	p- value
Right knee	14.30 \pm 0.88	21.16 \pm 1.57	<0.0001*
Left knee	13.26 \pm 1.18	20.04 \pm 1.87	<0.0001*

* Indicates significant gender difference (using Independent t-test)

Discussion

In the present study we identified the baseline values of Q-angle for Indian and East African adult. The Q-angle values in Group-I subjects are consistent with earlier studies done on white Americans [4,15-17]. However the values were higher than previous studies done on Indians [5,6]. The reason is the earlier authors have taken the measurements in supine position and our subjects were standing erect with Quadriceps relaxed.

Q-angle values in Group-II females were higher than those reported by Jaiyesimi and Jegede [18] who in their study on Nigerian population reported the average Q-angle in the female subject ($n = 200$) $17.06^\circ \pm 3.64$ and $14.84^\circ \pm 3.47$ for the right and left limb. Another study on Nigerian population of Urhobo ethnicity establishes the average Q-angle for the right and left lower limb in the female group ($n=100$) had their RQA and LQA as $16.93^\circ \pm 1.35$ and $16.30^\circ \pm 1.20$ respectively [19]. However the values were lower than Omololu et al. [7] who in his study on Nigerian population females ($n=123$) reported RQA and LQA as $22.8^\circ \pm 4.7$ and $22.7^\circ \pm 4.6$. The possible explanation for this difference in Q-angle values compared to previous studies is our subjects belong to east Africa whereas above mentioned authors did study on Nigerian population.

Bilateral Asymmetry

In the present study RQA was higher than the LQA in both the groups this is consistent with the result of previous authors [16,18,20], but differs with other authors who have reported higher LQA than RQA [21-23]. One of the explanations put forth for bilateral asymmetry is difference in the quadriceps strength. It was found that the Q angle is inversely related to the peak torque angle during active knee extension [17]. The other reasons postulated are relative alteration in the positions of the CP or TT. Higher Q-angle values were associated with lateral placement of the TT with respect to the CP [20]. However in the present study we have only measured the Q-angle and its alteration with positions of the CP or TT will be done in subsequent studies.

Gender

In Group-I as well as in Group-II, females had significantly higher Q-angle as compared to males, this is consistent with previous studies [4,6,15,19,23] There are many reasons being documented for higher Q-angles in females, theoretically the combination of

wider hip and shorter femurs could increase the valgus of the lower limbs and thus increase the Q-angle [24]. Grelsamer et al. (2005) concluded that the slight difference in Q angles between men and women can be explained by the fact that men have longer femur and tend to be taller [25] gender difference in Q angle also depends on strength of muscle contraction [17]. The Q angle in females showed a significant positive correlation with the relative lateral placement of the TT [5,6] A more laterally placed TT in females could be due to an increase in the valgus angle or tibial torsion [26].

A higher Q-angle alters lower limb biomechanics and this has been associated with greater incidence of patellofemoral disorders hence females are more prone to patellofemoral pain syndrome, anterior knee pain and recurrent lateral subluxation of the patella.

Conclusion

The present study has documented Q-angle values for two different races. The east African subjects had significantly higher values compared to Indian subjects. More similar studies with larger sample size need to be undertaken and should also be correlated radiologically to authenticate the result.

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The manuscript has not been presented or sent for publication elsewhere

Conflict of Interest

Nil

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