Clin Orthop Relat Res (2009) 467:2073–2076
DOI 10.1007/s11999-008-0637-1

ORIGINAL ARTICLE

Normal Q-angle in an Adult Nigerian Population

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Received: 19 June 2008 / Accepted: 10 November 2008 / Published online: 26 November 2008

Abstract The Q-angle has been studied among the adult Caucasian population with the establishment of reference values. Scientists are beginning to accept the concept of different human races. Physical variability exists between various African ethnic groups and Caucasians as exemplified by differences in anatomic features such as a flat nose compared with a pointed nose, wide rather than narrow faces, and straight rather than curly hair. Therefore, we cannot assume the same Q-angle values will be applicable to Africans and Caucasians. We established a baseline reference value for normal Q-angles among asymptomatic Nigerian adults. The Q-angles of the left and right knees were measured using a goniometer in 477 Nigerian adults (354 males; 123 females) in the supine and standing positions. The mean Q-angles for men were 10.7° ± 2.2° in the supine position and 12.3° ± 2.2° in the standing position in the right knee. The left knee Q-angles in men were 10.5° ± 2.6° in the supine position and 11.7° ± 2.8° in the standing position. In women, the mean Q-angles for the right knee were 21° ± 4.8° in the supine position and 22.8° ± 4.7° in the standing position. The mean Q-angles for the left knee in women were 20.9° ± 4.6° in the supine position and 22.7° ± 4.6° in the standing position. We observed a difference in Q-angles in the supine and standing positions for all participants. The Q-angle in adult Nigerian men is comparable to that of adult Caucasian men, but the Q-angle of Nigerian women is greater than that of their Caucasian counterparts.

Introduction

The Q-angle is defined as the acute angle formed by the vector for the combined pull of the quadriceps femoris muscle and the patellar tendon. It can be measured as the acute angle formed by straight lines drawn from the anterior-superior iliac spine (ASIS) to the center of the patella and from the center of the patella to the tibial tuberosity [10]. This angle can be measured in the supine or standing position with the hip and knee extended and the quadriceps muscle relaxed. The Q-angle has been implicated as one of several factors in various knee disorders [3, 15, 22]. The Q-angle has been studied in Caucasian populations and normal reference values have been established. The American Orthopaedic Association considers 10° to be normal and 15° to 20° to be abnormal [14]. Some authors consider a Q-angle greater than 15° for men and 20° for women abnormal [11]. Studies have consistently shown women have a greater Q-angle than men [7, 9, 13, 23]. 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, 21].

Scientists are beginning to accept the concept of different human races [12]. Physical variability exists between various African ethnic groups and Caucasians as

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exemplified by differences in anatomic features such as a flat nose compared with a pointed nose, wide rather than narrow faces, straight rather than curly hair, and differences in pelvic anatomy [6, 12]. A recent study showed there is a difference in the pelvic anatomy between African-American women and Caucasian women [6]. Caucasian women have a wider pelvic inlet, a wider outlet, and a shallower anteroposterior diameter than African-American women [6]. In another study, the prevalence of ischemic heart syndromes was the same in blacks and whites, but the mortality from sudden cardiac deaths was higher in blacks [4]. This is the result of the different anatomic substrates of ischemia and sudden cardiac deaths between them. Blacks had a higher mortality rate resulting from the associated left ventricular hypertrophy in them compared with whites. Ocular anatomic differences also are observed between races and different ethnicities [2]. There are anatomic differences between Africans and Caucasians and therefore we cannot assume the same Q-angle values will be applicable to both. In a previous study, a difference in knee angles between Nigerian children and Caucasian children was reported [18]. Also, the predominant patellofemoral arthritis seen in Nigerian women provoked curiosity to further study why this is so [17].

The aims of this study were to (1) establish a baseline reference value for normal Q-angles among asymptomatic Nigerian adults; and (2) determine whether those values differed in men or women in Nigerian and Caucasian populations.

Materials and Methods

We identified a sample of 354 males and 123 females. These subjects were volunteers and were randomly selected from a stratified cross section of the society. The subjects were normal asymptomatic adults as determined by a thorough clinical examination. Subjects with gait abnormality, knee swelling, abnormalities in active or passive range of motion, and areas of localized knee tenderness were excluded. We did not confirm the findings radiographically. We also excluded subjects who had at any time reported knee pain or who had obvious valgus or varus deformity by clinical evaluation. The average age of the men was 24.6 years (range, 18–31 years); the average age of the women was 22.6 years (range, 19–33 years). All subjects were informed about the purpose of the study and signed consent was obtained.

We recorded the age and gender of each subject and gave the subjects instructions regarding positioning for measurement. The right and left knees were measured with the subjects in the standing and supine positions. All subjects were measured using the same goniometer (Samrat stainless steel manual goniometer, Samrat Stainless Steel, Madras, India). We palpated the ASIS and the proximal end of a string was taped to the ASIS. The borders of the patella were palpated and the center was identified. We taped the distal end of the string to the center of the patella after making it taut. The tibial tuberosity was palpated and tape was placed on the most prominent part of it. Measurements were made from the upper margins of the tape. We placed the fulcrum of the goniometer on the center of the patella and the short arm was placed over the most prominent part of the tibial tuberosity while the long arm was aligned along the length of the string joining the ASIS to the center of the patella.

We first measured each subject in the supine position and then the standing position without shoes. While in the supine position, both lower limbs were placed together such that both knees touched each other and the feet were pointed directly up. All measurements were performed with the knee extended and subjects were instructed not to flex their quadriceps muscle. In the standing position, we instructed subjects to stand in their normal stance with the feet pointing directly in front. They were instructed not to flex their quadriceps muscle. The Q-angle in degrees thus was measured.

Six observers determined the Q-angles for all 354 subjects. These observers were physicians trained to measure the Q-angle in subjects. Before data collection, we calculated intertester and intratester reliability correlation coefficients for 20 subjects. The coefficients for the supine position were 0.89 and 0.90, respectively whereas those for the standing position were 0.92 and 0.91, respectively.

Descriptive data were calculated. The differences in Q-angles between men and women and between supine and standing positions were quantified using the t-test. The data were normally distributed as tested by the Kolmogorov-Smirnov test. We used the Statistical Package for the Social Sciences (Version 10; SPSS, Chicago, IL) for all analyses (Table 1).

Table 1. Descriptive statistics for Q-angles

Parameter	Men (N = 354)		Women (N = 123)	
	Supine	Standing	Supine	Standing
Right knee	10.7 ± 2.2	12.3 ± 2.2	21 ± 4.8	22.8 ± 4.7
Left knee	10.5 ± 2.6	11.7 ± 2.8	20.9 ± 4.6	22.7 ± 4.6
Change in Q-angle (right knee)	1.6 ± 1.4		1.8 ± 3.5	
Change in Q-angle (left knee)	1.2 ± 1.5		1.8 ± 3.0	

All values are mean ± standard deviation.

Results

The average Q-angles for the right knee in men were 10.7° ± 2.2° in the supine position and 12.3° ± 2.2° in the standing position. The left knee Q-angles in men were 10.5° ± 2.6° in the supine position and 11.7° ± 2.8° in the standing position. In women, the average Q-angles for the right knee were 21° ± 4.8° in the supine position and 22.8° ± 4.7° in the standing position. The average Q-angles for the left knee in women were 20.9° ± 4.6° in the supine position and 22.7° ± 4.6° in the standing position. Nigerian women had a greater Q-angle than men. The right and left Q-angles were similar ($p = 0.26$). In men and women the right knee Q-angle correlated ($r = 0.90$, $p < 0.01$) with the left. Increases in Q-angle of 1.2° to 3° were observed in men and 1.8° to 5.3° in women from the supine to the standing position (Table 2).

The mean Q-angles (for right and left knees) were greater ($p < 0.01$) for women than men in supine (21.0° versus 10.7° and 21.0° versus 10.7°, respectively) and standing (21.0° versus 10.6° and 22.7° versus 11.7°, respectively) positions. Body mass index did not influence ($p = 0.509$) the Q-angle.

Discussion

Anatomic differences between various African ethnic groups and Caucasians have been documented [2, 6, 12]. Ocular anatomic and pelvic anatomic differences are well documented [2, 6]. We therefore cannot assume the Q-angle in Caucasians would be the same as the Q-angle in Africans. We identified the baseline value of the Q-angle in an adult Nigerian population and found it differs in Nigerian women compared with Caucasian women.

Our study was not without limitations. We did not include randomization of position (supine versus standing). The location of anatomic landmarks in measuring the Q-angle is fraught with errors of positioning and consistency in identification of the tibial tuberosity, which is a broad region in the upper tibia. We do not believe this would affect our findings considerably because trained doctors identified the landmarks before positioning the string and tape. Using tape to stabilize the string predisposes to shifting of the string during measurements; however, such shifts would not be enough to alter the Q-angle considerably, especially if the tape secures the string adequately to the skin.

Our data establish Q-angles of as much as 14.5° as the upper limit of normal for adult Nigerian men and 27.5° as the upper limit of normal for adult Nigerian women. Our data for the Q-angle in men are consistent with those of previous studies in adult Caucasian men but differ considerably in adult women [3, 5, 9]. A Q-angle greater than 20° is considered abnormal in women, but our study shows the normal Q-angle in adult Nigerian women ranges from 20° to 28°. The reason for this is not well understood; however, a possible explanation could be adult Nigerian women may have a broader hip or shorter femur than their Caucasian counterparts. We did not study the Q-angle in relation to hip width or femur length. This should be investigated further. However, many of our female patients present with anterior knee pain in which the radiographic findings are normal, and we need to ascertain whether this is related to increased knee angle [17].

Some studies suggest the Q-angle is related to knee pain and recurrent dislocation of the patellofemoral joint [1, 20]. Any increase in Q-angle shifts the patella laterally and rotates it medially such that there is an increase in the lateral patellofemoral contact pressures. This contributes to joint instability [16]. Despite the debate regarding the reliability of Q-angle measurements for patellofemoral disorders, it still is used as a predictor of patellar alignment in relation to lower extremity biomechanics [5].

We found no major difference between Q-angles of the right and left knees contrary to the findings of Hahn and Foldspang and Holmes and Clancy [5, 8]. We observed a trend of a difference in the Q-angle from the supine to the standing position, although the difference was significant in our study for reasons unknown to us. The practical importance of this clinically is unclear but should be taken in context with clinical symptoms and signs of knee disorders. A majority of our subjects had an increase in Q-angle from supine to standing position (Table 2). This increase can be attributed to weightbearing mechanics during the standing position.

We have established the Q-angles for adult Nigerian men to range from 10° to 14° and adult Nigerian women to range

Table 2. Change in Q-angle (increase, decrease, or no change from supine to standing position)

Gender	Increase				Decrease				No change			
	Right knee		Left knee		Right knee		Left knee		Right knee		Left knee	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Men (N = 354)	295	83.3	242	68.4	11	3.1	15	4.2	48	13.6	97	27.4
Women (N = 123)	92	74.8	91	74	21	17.1	22	17.9	10	8.1	10	8.1

from 21° to 28°. The Q-angle for Nigerian men is similar to that of Caucasian men, but that of women differs. We therefore propose the cutoff limit for an abnormal Q-angle in adult Nigerian women be revised to be greater than 28°.

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