Anterior Knee Pain (AKP) and its Relationship to Quadriceps Angle and Anthropometric Parameters: A Hospital-Based Cross-Sectional Study from Iraq

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Abstract

Background: Anterior knee pain (AKP) is a common condition, especially among physically active adults who present a clinical challenge. Patellar malalignment is thought to be an important cause. Measuring quadriceps (Q) angle significant test used in the assessment of patellar alignment and hence used in the assessment of AKP. **Objectives:** To assess the relationship between AKP and Q angle among ample Iraqi patients. **Materials and Methods:** The right and left Q angles of 100 participants were measured using a universal goniometer. The participants were divided into three groups: controls, patients with left AKP (LAKP), and patients with right AKP (RAKP). The relationship between Q angles and different groups was tested using appropriate statistical tests. **Results:** The left Q angles for males measure 14.1 ± 1.9 in controls, 17.7 ± 1.6 in LAKP cases and 16.1 ± 1.8 in RAKP cases, and for the females 16.1 ± 1.8 in controls, 18.1 ± 1.8 in LAKP cases and 17.1 ± 2.5 in RAKP cases. The right Q angles for males measure 15.6 ± 2.2 in controls, 15.1 ± 2.7 in LAKP cases and 19 ± 1.6 in RAKP cases, and for the females were 17.7 ± 2.4 in controls, 17.9 ± 2.2 in LAKP cases and 19.9 ± 2 in RAKP cases. Both Q angles (right and left) were greater in females than in males and both were greater in cases than in controls. **Conclusion:** The study concluded that there is a significant association between AKP and quadriceps femoris angle measurement in both genders. Therefore, clinical and/or radiological demonstration of quadriceps angle can be used as a means for initial detection of AKP.

Keywords: Anterior knee pain, Iraq, patellofemoral syndrome, Q angle

Introduction

Anterior knee pain (AKP) also known as patellofemoral pain syndrome (PFPS) is an umbrella term used to define pains arising from the knee joint itself, or the surrounding soft tissues, and that is aggravated by daily activities like stairs climbing, crouching, running jumping, and/or sitting with a flexed knee for a long period.[1]

AKP is a common condition, especially among physically active adults, it affects 25% of athletes, and 70% of the cases are in the age group of 16–25 years.[2] AKP shows a good response to physical therapy but relapse can occur in more than 60% of cases leading to restriction in daily activities and long-term medical treatment.[3]

Quadriceps angle is well defined as the angle located between the quadriceps femoris and patellar ligament. It was first defined in 1964 by Hakan Brattstrom (Swiss surgeon).[4] It is regarded as an imperative clinical index that shows the biomechanical product of the quadriceps femoris muscle on the knee joint, and it is also considered a key factor for the correct posturing and movement of the patella. Quadriceps angle is frequently used as a clinical parameter during the assessment of patients with knee joint problems, such as in AKP.

Access this article online

Quick Response Code:

Website: https://journals.lww.com/mjby

DOI: 10.4103/MJBL.MJBL_739_23

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Submission: 12-Jun-2023 **Accepted:** 30-Sep-2023 **Published:** 17-Jul-2024

How to cite this article: Al-Shamari AL, Assi MH, Al-Abbasi M. Anterior knee pain (AKP) and its relationship to quadriceps angle and anthropometric parameters: A hospital-based cross-sectional study from Iraq. Med J Babylon 2024;21:353-8.

As documented by many literatures, the normal values of the Q angle are 12°–20°, where males tend to have lower measurements than females.[5,6] Some recent studies have demonstrated that values of 8°–10° for males and 8°–15° for females are considered normal, but readings that are greater than those are considered abnormal. Davies and Larson regard a Q angle of more than 20° as excessive.[7]

Numerous kinds of research propose that there is a significant correlation between Q angle and AKP.[8,9]

Increased Q-angle added biomechanical stress on the knee especially during repetitive activities because it restricts the even patellar movement inside the femoral groove.[10,11] With time, this will cause a muscular imbalance and ultimately wearing of the cartilage underneath the patella that can result in the loosening of the knee joint articular surface.[12] Consequently, the resulting damage becomes permanent which renders full recovery after treatment not possible.

Furthermore, extreme Q angle results in extreme foot pronation which might cause excessive internal tibial rotation that will alter the quadriceps muscular mechanism and lateral patellar tracking.[13] Ultimately, this leads to a quick progression from knee joint dysfunction to patellofemoral pain and hence to joint degeneration.[14]

Most of the research performed on the Western population, who have anthropometric indices and physical activities that may differ from those of the Iraqi population, so, its authenticity in our population is obscure. Hence this study aimed to determine the association between AKP and Q-angle in a sample of the Iraqi population.

Materials and Methods

Study design

The study is hospital-based, cross-sectional comparative in design carried out in Al-Mustansiriyah Medical College and the Orthopedic Department of Al-Yarmouk Teaching Hospital, Baghdad, Iraq. The study includes 100 adult individuals who had visited the orthopedic outpatient department during the period (January 2023–June 2023) for various indications, for example, joint pain, backache, trauma, limping, and others.

Exclusion criteria

The patients with trauma history; hip, ankle, and spine pathologies; gross knee joint abnormality; knee joint surgery; ligamentous laxity and congenital abnormalities of lower limb.

Materials

A plastic goniometer (Passionate Care, Spain) was used for measuring the Q angles in degrees.

Methods

The Q-angles of both knees were recorded for all participants (controls [n = 50], cases with right anterior knee pain [RKP] [n = 25], and cases with left anterior knee pain [LKP] [n = 25]) by two unrelated examiners who were unaware of the measures attained by each other, using a plastic goniometer in the supine position (the participant was supine, his/her quadriceps muscles relaxed and knee joints flexed 10°. The hip and leg were maintained in a neutral position with the patella pointing upwards, and the longitudinal axis of the foot is vertical to the horizontal line). The anterior superior iliac spine (ASIS), the midpoint of the patella (MP), and the tibial tuberosity (TT) were localized manually. One end of a cord was placed at the ASIS. The other cord end was placed below MP. The hinge of the goniometer was placed at MP, the fixed arm of the goniometer was allied with the part of the cord leading to ASIS, while the movable arm of the goniometer was allied with the TT.[15] Two readings were recorded and the average was taken as the final reading.

Statistical analyses were performed using SPSS version 26 and Microsoft Office Excel 2021. Continuous data were presented as mean ± SD. Intergroup and intragroup comparison was performed using the analysis of variance (ANOVA) test and t test. The correlation between the two groups was performed by Pearson's correlation coefficient (r). A probability value of $P < 0.05$ was considered statistically significant.[16]

Ethical approval

The study was directed under ethical principles that have their source in the WMA Declaration of Helsinki. It was conducted with patients' verbal and analytical approval and was ethically approved by the local committee of Al-Mustansiriya Medical College (reference no. 126, date December 21, 2022).

Results

The total number of participants in this study was 100 (n = 100). The percentile contribution of males and females was 50% and 50%, respectively. Their descriptive statistics are summarized in Table 1.

Regarding controls, the Q angle for the left knee (Q-L) ranged from 11° to 20° with a mean Q-L of 14.1 ± 1.9 for males, and 16.1 ± 1.8 for females. The Q angle for the right knee (Q-R) ranged 12°–22° with a mean of 15.6 ± 2.2 for males, and 17.7 ± 2.4 for females.

Regarding cases, the Q angle for the left knee (Q-L) ranged 12°–24° with a mean Q-L of 16.8 ± 2 for males, and 17.7 ± 2.1 for females. The Q angle for the right knee (Q-R) ranged 12°–23° with a mean Q-R of 17.5 ± 2.7 for males, and 18.7 ± 2.3 for females.

Table 1: Descriptive statistics of cases and controls

Subjects	Gender		Age (years)	Weight (kg)	Height (cm)	BMI (kg/m²)	BSA (m²)	Q-L (°)	Q-R (°)
Controls	Males	Min	18	60	164	21.30	1.66	11	12
		Max	50	102	181	31.83	2.25	18	20
		Mean	37.80	77.48	172.1	26.17	1.92	14.1	15.6
		SD	9.785	10.26	5.29	3.19	0.14	1.85	2.22
	Females	Min	17	58	155	22.04	1.58	13	14
		Max	67	90	179	34.37	2.08	20	22
		Mean	34.88	73.92	165.9	26.88	1.84	16.1	17.72
		SD	12.13	9.46	9.4	3.30	0.14	1.78	2.39
Cases	Males	Min	23	60	168	20.34	1.68	12	12
		Max	70	102	185	31.96	2.28	20	24
		Mean	51.88	78.60	176.1	25.34	1.96	16.76	17.48
		SD	15.35	10.96	5.295	3.24	0.15	1.964	2.69
	Females	Min	22	58	159	22.16	1.60	14	14
		Max	70	100	183	33.09	2.20	22	23
		Mean	45.24	75.44	169.9	26.166	1.88	17.68	18.76
		SD	15.52	9.62	6.39	3.26	0.13	2.13	2.28

Q-L: left Q angle, Q-R: right Q angle, BSA: body surface area, BMI: body mass index

Table 2: paired sample *t* test statistics (Q-R vs. Q-L)

Q-angle	No.	Mean	SD	*t*	*df*	*P* value
Q-R	50	16.68	2.511	9.084	49	0.000
Q-L	50	15.08	2.059			

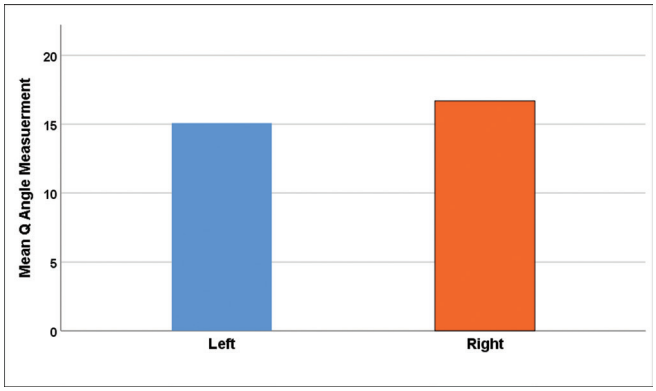

Figure 1: Comparison of right and left Q angles in the control group

Table 3: ANOVA test (cases vs. controls)

Subjects		SS	*df*	MS	F	*P* value
Q-L	Between groups	114.490	1	114.490	26.698	0.000
	Within groups	420.260	98	4.288		
	Total	534.750	99			
Q-R	Between groups	51.840	1	51.840	8.088	0.005
	Within groups	628.160	98	6.410		
	Total	680.000	99	114.490		

A paired sample *t* test confirmed that there was a significant difference in Q angle measurement between the right and left sides of the control group in both males and females, where the right Q angle is greater than the left Q angle (16.7 ± 2.5 vs. 15.1 ± 2.1, *P* value < 0.001) [Table 2, Figure 1].

Table 4: Independent *t* test statistics (cases vs. controls)

Cases vs. controls		No.	Mean	SD	*t*	*df*	*P* value
Q-L	Cases	50	17.22	2.083	5.167	98	0.000
	Controls	50	15.08	2.059			
Q-R	Cases	50	18.12	2.553	2.844	98	0.005
	Controls	50	16.68	2.511			

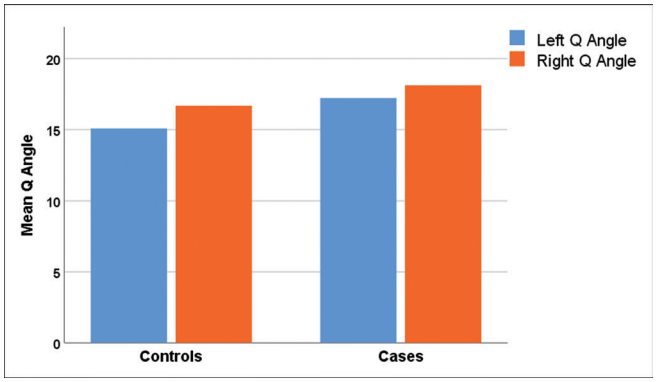

Figure 2: Comparison of Right and Left Q Angles between cases and controls

The analysis of variance and covariance (ANOVA) confirmed the presence of a statistically significant difference between cases and controls in connection with Q angle measurements (*P* value < 0.001 for Q-L and <0.05 for Q-R) [Table 3].

These inferences were also confirmed via *t* test that revealed a significant difference of cases over controls for the Q-L (*P* < 0.001) and Q-R (*P* = 0.005) [Table 4 and Figure 2].

Table 5: ANOVA test (females vs. males)

Subjects		SS	*df*	MS	F	*P* value
Q-L	Between groups	53.290	1	53.290	10.847	0.001
	Within groups	481.460	98	4.913		
	Total	534.750	99			
Q-R	Between groups	70.560	1	70.560	11.346	0.001
	Within groups	609.440	98	6.219		
	Total	680.000	99			

Table 6: Independent *t* test statistics (females vs. males)

Cases vs. controls		No.	Mean	SD	*t*	*df*	*P* value
Q-L	Males	50	15.42	2.322	−3.293	98	0.001
	Females	50	16.88	2.106			
Q-R	Males	50	16.56	2.612	−3.368	98	0.001
	Females	50	18.24	2.370			

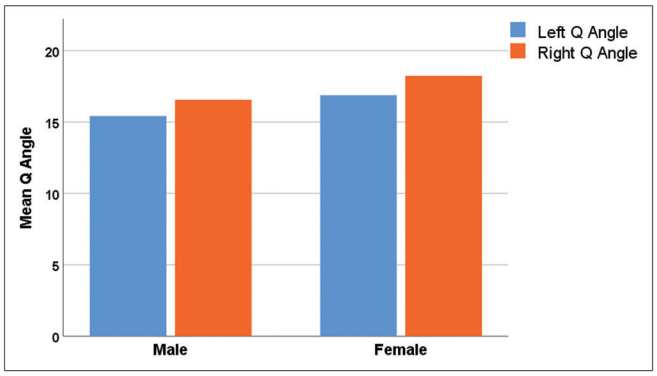

Figure 3: Comparison of right and left Q angles between males and females

The analysis of variance and covariance (ANOVA) confirmed the presence of a statistically significant difference between males and females in connection with Q angle measurements [Table 5].

These findings were fortified via *t* test that exposed a significant difference between males and females for the Q-L ($P = 0.001$) and Q-R ($P = 0.001$) [Table 6 and Figure 3].

An independent *t* test exposed a significant difference in Q-L measurements between LKP cases over controls (17.92 vs. 15.08, $P < 0.001$), and also between LKP cases over RKP cases (17.92 vs. 16.52, $P < 0.05$) [Table 7 and Figure 4].

An independent *t* test detects a significant difference in Q-R measurements between RKP cases over controls (19.41 vs. 16.68, $P < 0.001$), and also between RKP cases over LKP cases (19.41 vs. 16.88, $P = 0.001$) [Table 8 and Figure 5].

Table 7: Independent *t* test statistics (Q-L)

LKP cases vs. controls		No.	Mean	SD	*t*	*df*	*P* value
Q-L	LKP cases	25	17.92	1.706	5.946	73	0.000
	Controls	50	15.08	2.059			
LKP cases vs. RKP cases							
Q-L	LKP cases	25	17.92	1.706	2.501	48	0.016
	RKP cases	25	16.52	2.220			

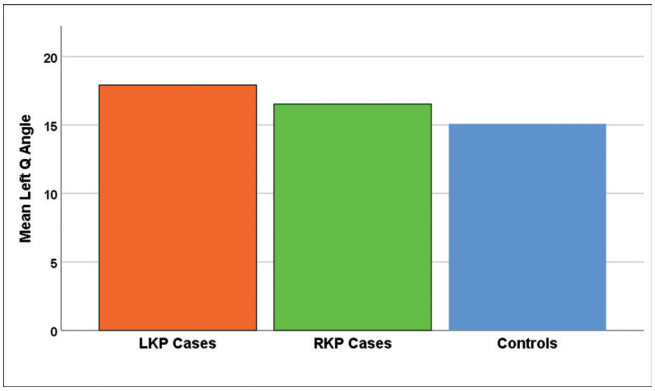

Figure 4: Comparison of left Q angles in different case groups

Table 8: Independent *t* test statistics (Q-R)

RKP cases vs. controls		No.	Mean	SD	*t*	*df*	*P* value
Q-R	RKP cases	25	19.36	1.777	4.756	73	0.000
	Controls	50	16.68	2.511			
LRKP cases vs. LKP cases							
Q-R	RKP cases	25	19.36	1.777	3.902	48	0.000
	LKP cases	25	16.88	2.635			

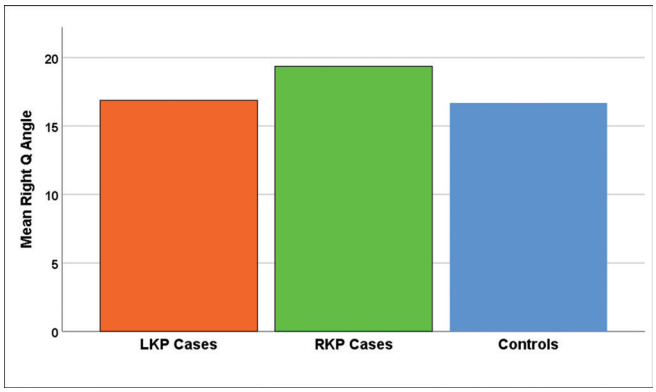

Figure 5: Comparison of right Q angles in different case groups

A Pearson correlation test was performed to investigate the effect of an individual's age upon Q angle measurements, the test concludes that there was no correlation between Q angle measurement and the other anthropometric measures (*P* value = 0.22) [Figure 6].

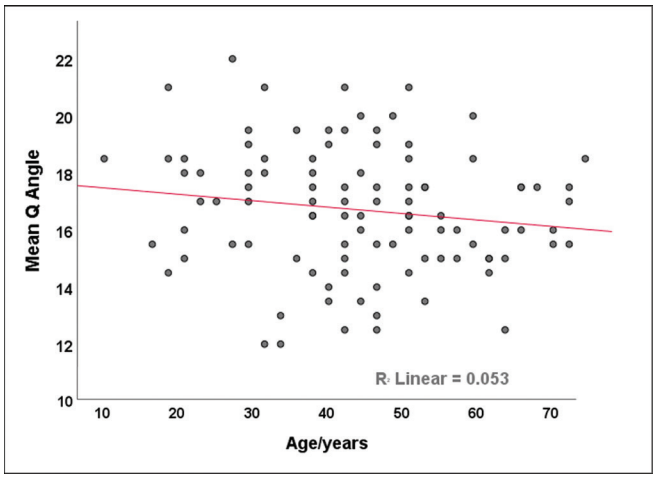

Figure 6: Scatter correlations and linear regressions: Q angles vs. age

Discussion

AKP is a common problem encountered by patients demanding orthopedic consultation. A patellar malalignment is depicted to be one of the causal factors for AKP. Q-angle measurement is commonly used to evaluate such a problem.[15-17] Q angle measurement can be executed using various methods, such as the radiological method (X-ray or CT scan) or clinical method by the use of a universal goniometer which can be performed in different ways (supine position, sitting position, and standing).[18]

The study found that the normal range for the left Q angle in the control group was 14.1 ± 1.9 for males, 16.1 ± 1.8 for females, and for the right Q angle was 15.6 ± 2.2 for males, and 17.7 ± 2.4 for females. These findings are in concurrence with the research done by Tella *et al.*,[19] Ebeye *et al.*,[20] and Khasawneh *et al.*[21]

The anatomical explanation for such difference was that a female's pelvis is wider than a male's which is inferred by having an extensive distance between the patella and the pelvis as compared to the distance from the patella to the tibial tuberosity, therefore inducing a positional alternation in ASIS which cause a large influence on the Q angle measurements.[22] Also, postural and social factors such as high-heeled shoes wearing, and sitting with adducted legs may be a causal factor.[23]

The study revealed a significant difference in Q angle measurement between the right and left sides in both males and females, where the right Q angle is greater than the left Q angle. These findings are in accord with findings reported by Hahn and Foldspang,[24] Byl *et al.*,[25] Livingston and Spaulding,[26] and Raveendranath *et al.*[27] Although slight bilateral alterations in Q angle measurement might be explained as a product of normal variation or slight measurement errors, however, significant differences prerequisite more explanations. One of these explanations is the bilateral difference in the strength quadriceps muscle. It was stated that the Q angle inversely varied with the peak twisting angle during active knee extension.

Our study shows that the mean Q-angle in the case groups was significantly greater than in controls. These findings were according to research done by Aglietti *et al.*,[8] Emami *et al.*,[9] Haim *et al.*,[28] Agrawal *et al.*,[29] Abdel-aziem *et al.*[30]

A higher Q-angle may lead to a higher valgus angle which affects the biomechanics of knee joint articulation by applying a laterally directed force that leads to abnormal tracking and extreme pressure on the knee joint articulation, subsequently resulting in AKP.[12]

In conclusion, the study concluded that there is a significant association between AKP and quadriceps femoris angle measurement in both males and females. Therefore, clinical and/or radiological expression of quadriceps angle can be used as a means for initial detection of AKP and henceforth necessitates the prerequisite for lifestyle alteration to counter this condition at its early stage. This study may have limitations including a relatively small sample size; besides, the study was based on individuals attending a single hospital rather than attending more than a health care center which could have led to a more reliable multicenter study. Nevertheless, our statistically valid research represents the only one conducted in Iraq (up to our knowledge) about the relationship between AKP and Q angle measurement.

Acknowledgment

Nil.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors declare that there is no conflict of interest.

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