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Association between Q angle and predisposition to gonarthrosis*

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Abstract

Objectives: The aim of our study was to evaluate the relationship between quadriceps angle (Q angle), body mass index (BMI), dominant side and pain severity in gonarthrosis patients.

Methods: In order to determine the Q angle in gonarthrosis patients, 205 volunteer patients (104 men and 101 women) diagnosed with gonarthrosis and 110 control subjects (60 men and 50 women) over 40 years of age were included. In the patient group, sides with pain, pain levels, right and left leg Q angle values, and dominant sides were evaluated.

Results: Right Q angle value was found 13.21°±3.22° in patients and 13.26°±2.04° in controls, while the left Q values were 12.86°±3.35° and 12.65°±2.52° in patients and controls, respectively. No significant difference was found between the right and left Q angles both for patients (p=0.885) and controls (p=0.568). When the pain levels and right Q angles of the patients were compared, a positive correlation between the Q angle elevation and increase in pain was found (p=0.001). In addition, the pain level increase and left Q angle elevation of the patients were also found positively correlated (p=0.004).

Conclusion: The results of this study show that measuring the Q angle, despite its low sensitivity and internal consistency levels, is an effective way of diagnosing and treating the lower extremity malalignments and related pathologies.

Keywords: dominant side; gonarthrosis; pain severity; Q angle

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Introduction

Osteoarthritis (OA) is a chronic rheumatic disease with a high incidence characterized with new bone formation on the articular surface of the joints, causing symptoms due to articular cartilage degeneration. It leads to reduced mobility in daily life and various complaints such as pain. Gonarthrosis is the most common form of OA and its prevalence increases with age. Radiological and pathological changes start presenting symptoms after the third decade of life.[1] While gonarthrosis is observed in 0.1% between 25–35 years of age, this rate rises over 80% in ages 65 and above.[2] Quadriceps angle or Q angle is a parameter used for the evaluation of the biomechanical condition of the knee joint and the regularity of the lower extremities. Q angle is defined as the angle between two axes drawn in the frontal plane, from spina iliaca anterior superior to the mid-point of patella, and from the mid-point of patella to tuberositas tibiae.[3] For Q angle measurements, a goniometer is widely used in clinics due to its practicality and low cost.[4] There is no common agreement on the normal value of the Q angle in the literature.[5,6] The American Orthopedics Association considers 10º as normal and range of 15º–20º as pathological, whereas Horton and Hall[7] described the normal value as 13.5º±4.5º for the general population, 11.2º±3º for men and 15.8º±4.5º for women. Other studies described Q angle values below 8º–10º for men and 15º for women as normal.[4,8] In the study of Schulthies et al.,[9] where they statistically gathered the data from numerous studies in literature, angles ranging between 10º–14º for men and 14.5º–17º for women were reported as normal.

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The aim of our study was to evaluate the relationship between Q angle, body mass index (BMI), dominant side and pain severity in gonarthrosis patients over 40 years of age.

Materials and Methods

Our study included 298 patients diagnosed with gonarthrosis according to basis of clinical and radiological examinations in the Physical Therapy Clinics of Adıyaman Training and Research Hospital and Gaziantep Dr. Ersin Arslan Training and Research Hospital. Patients who went under knee surgery, trauma, knee injection in the last six months, and who received physical therapy in the past year were excluded. In order to compare the Q angles, 110 healthy adult volunteers were used. Volunteers with lower extremity amputation, prosthesis, fracture, use of any walking assistant or walking equipment were excluded. All patients and volunteers were submitted to an assessment protocol including interview and physical examination. Of the 298 patients assessed according to the protocol, 205 patients were included; the remaining patients matched one or more of the exclusion criteria. All measurements were taken by the same physical therapist at the Physical Therapy Unit of Adıyaman Training and Research Hospital and Gaziantep Dr. Ersin Arslan Training and Research Hospital. This study was approved by the Ethics in Research Committee of Kahramanmaraş Sütçü İmam University, under protocol number 2013/15–3, and voluntary informed consent forms were obtained from the participants.

Gender, age, height, weight, occupation, complaint, medical history, background and family history information were recorded for those who met the inclusion criteria among the patients and control subjects. Manual measurements were performed with a standard goniometer compatible with the technique for Q angle assessment as shown in **Figure 1**.[10] BMI of every participant was calculated to determine obesity based on World Health Organization (WHO) obesity classification. BMI ranges were as follows - underweight: under 18.5 kg/m^2; normal weight: 18.5 kg/m^2 to 24.99 kg/m^2; overweight: 25 kg/m^2 to 30 kg/m^2; obese: over 30 kg/m^2.

For the evaluation of pain, visual analog scale (VAS) was used compatible with the technique as described in the literature.[11] The dominant sides were determined by asking the participants which hand they prefer for writing and physically demanding activities.

IBM SPSS Statistics for Windows (Version 22.0, Armonk, NY, USA) was used for statistical analyses and values of $p<0.05$ were considered statistically significant. For the control of the continuous variable's compatibility to normal distribution, Kolmogorov-Smirnov test was used. For the comparison of the variables with normal distributions between two independent groups, Student's t-test and for the two dependent measurement comparisons the paired t-test was performed. Association between the numerical variables and categorical variables were tested using Pearson's correlation coefficient and chi-square tests, respectively. For numerical variables mean ± standard deviation, and for categorical variables number and % values were calculated.

Results

In this study, 205 patients (104 men and 101 women) and 110 control subjects (60 men and 50 women) that met our inclusion criteria were included in this study. Demographic

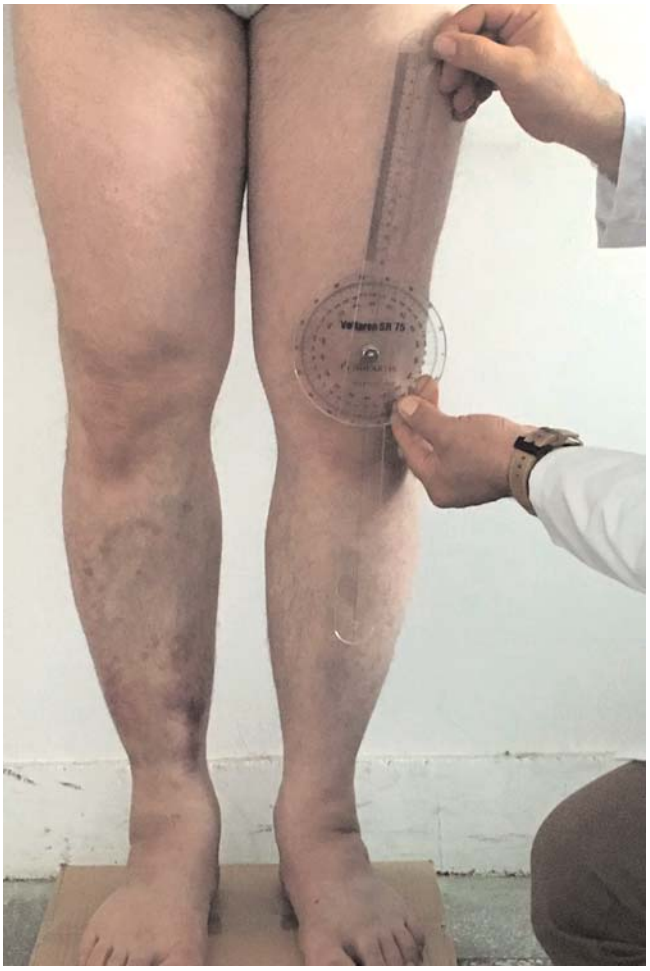

Figure 1. Measurement of Q angle with a standard goniometer. [Color figure can be viewed in the online issue, which is available at www.anatomy.org.tr]

features of the gonarthrotic patients and control subjects are shown in **Table 1**. No significant difference was found between the two groups in terms of age, height, BMI and right and left Q values. On the other hand, patients weighed heavier than the healthy volunteers (**Table 1**; p=0.032). There was no significant difference between the Q values of the gonarthrosis patients and control subjects. In fact, the mean Q values of the individuals over 40 were observed to be approximately the same. In the patient group, no significant difference was observed between the right and left Q angle values (p=0.096). Yet, in the healthy group the right Q value was found significantly higher (**Table 2**; p=0.001). When the two groups were compared for BMI, no significant difference was observed. 136 of the patients were overweight, while 129 were Type 1 obese (**Table 3**; p=0.015). When dominant side was evaluated, no significant difference was found between the left and right sides (p=0.258). While no significant association was found for the patients that used their left side dominantly, a predisposition to gonarthrosis was observed for the patients that used their right side dominantly (**Table 4**; p=0.042). There was a positive correlation between pain severity and right Q (r=0.236, p=0.001) and left Q angle (r=0.199, p=0.004) values in gonarthrosis patients.

Discussion

This study was conducted on the hypothesis that the knowledge of the Q angle may help in the diagnosis of the commonly observed gonarthrosis disease and for being informed about the health precautions that must be taken. In recent studies, goniometers were shown to be reliable for measuring the Q angle.[12] Yet, there are also studies criticizing goniometric measurements, stating that only a 1–5 mm shift from the pivot points used for the goniometer measurements to the mid-point of the patella may result in a 1.13° to 5.53° measurement error.[13] Since errors in the pivot points may result with such outcomes, it was suggested that differences up to 4° between the right and left extremity Q angles may raise questions on its credibility.[14]

Another controversy on the Q angle is the difference between the right and left extremities. In this study, there was no significant difference found between the right and left knee Q angles of patient and healthy groups. While the mean Q angle measurements of the gonarthrosis patients was found as 13.21° for the right knee and 12.86° for the left knee, in the healthy group these values were 13.26° and 12.65°, respectively. In contrast to the study of Horton and Hall[7] where the right leg Q angle value was higher than the left leg Q angle value, Livingstone and Spaulding[4] found the left leg Q angle value higher than

Table 1
Demographic data of gonarthrosis patients and controls.

Groups	Q angle	n	Mean±SD	p
Gonarthrosis	Right	205	13.21°±3.22°	0.096
	Left	110	12.86°±3.35°	
Controls	Right	205	13.26°±2.04°	**0.001***
	Left	110	12.6°±2.52°	

*Independent samples t-test; difference is statistically significant at the level of p=0.032.

Table 2
Comparison of Q angles of gonarthrosis patients and control subjects.

Groups	Q angle	n	Mean±SD	p
Age (year)	Gonarthrosis	205	57.34±7.72	0.090
	Controls	110	55.85±6.80	
Height (cm)	Gonarthrosis	205	164.95±8.69	0.253
	Controls	110	163.83±7.42	
Weight (kg)	Gonarthrosis	205	82.55±11.21	0.032*
	Controls	110	79.99±7.33	
BMI (kg/m²)	Gonarthrosis	205	30.39±3.97	0.215
	Controls	110	29.86±2.80	
Pain severity	Gonarthrosis	205	5.95±1.53	–
	Controls	110	–	
Right Q angle	Gonarthrosis	205	13.21±3.23	0.885
	Controls	110	13.26±2.04	
Left Q angle	Gonarthrosis	205	12.86±3.35	0.568
	Controls	110	12.65±2.52	

*p=0.001

Table 3
BMI distribution in gonarthrosis patients and controls.

BMI	Gonarthrosis	Controls	Total
Normal (18.5–24.9)	16 (7.8%)	4 (3.6%)	20 (6.3%)
Overweight (25–29.9)	80 (39%)	56 (50.9%)	136 (43.2%)
Obese Type 1 (30–40)	83 (40.5%)	46 (41.8%)	129 (41%)
Obese Type 2 (40.1–50)	26 (12.7%)	4 (3.6%)	30 (9.5%)
Total	205 (100%)	110 (100%)	315 (100%)

Table 4
Comparison of the pain side and dominant side in gonarthrosis patients.

	Dominant side		
Pain side	Right	Left	Total
Right	87 (50.9%)*	10 (29.4%)	97 (47.3%)
Left	33 (19.3%)	12 (35.3%)	45 (22%)
Bilateral	51 (29.8%)	12 (35.3%)	63 (30.7%)
Total	171 (100%)	34 (100%)	205 (100%)

*Chi-square test, statistically significant at the level of p=0.042.

the right. Similarly, in the study by Denizoğlu[15] conducted on 77 healthy individuals, the left leg Q angle values were also found higher. In our study, in both patients and healthy individuals, the right leg Q angle values were found higher compared to the left side.

There is also controversy on the position of the subjects during Q angle measurement. When the Q angle is measured while standing, it is found approximately 1.4° higher in men and 2.4° higher in women compared to measurements in supine position. This variance may be due to the fact that the standing position is affected more by foot-ankle and hip joints than the supine position, and it is notified that in order to reduce this effect, the supine position should be preferred.[16] Yercan and Taskiran[17] confirmed this finding and indicated that an increase in the femoral anteversion would lead to an internal rotation of the femur. In this circumstance, the femoral cavity may turn medial and thus the patellar tendon may adhere more laterally on the tibia. Consequently, an increase in the Q angle will be observed. Likewise, in case of an external tibial torsion, characterized with extreme external physical rotation of the feet, tuberositas tibiae was reported to be located to more lateral to increase the Q angle. In this context, internal or external rotation of the feet by 15° was indicated to accompany with a 5° increase or decrease in the Q angle.[4,17] We performed our study while patients were in the standing position.

Age is also considered to have an effect on the Q angle. Bayraktar et al.[18] investigated the relationship between Q angle and age. They observed that children and adolescents had higher Q angle values compared to adults. Hsu et al.[19] found no significant relationship between age and Q angle in age groups 25–40 and 41–60. According to WHO statistics, gonarthrosis is the fourth leading cause of disabilities in women and the eighth in men.[1] The effect of obesity on gonarthrosis development has also been studied studied.[1,18,20,21] On the contrary, Kalpakçıoglu and Çakmak[20] found no difference regarding age and weight in 30 patients aged 40–60 years. In our study, no significant relation was found relating BMI between the patient and healthy groups, while a significant association was observed between the weight and the patient group.

Position of the knee joint is also counted as an additional factor affecting the Q angle. In full extension, patella does not contact the patellar surface of the femur, while at 90° flexion the lateral joint side of the patella is in touch with the outer and lower part of the patellar surface of the femur. Thus, patella can move laterally downwards. These changes of the position of the femur, tibia and patella during flexion and extension of the knee joint significantly lower the Q angle in 90° flexion compared to extension. In their study on 1340 athletes, Skalley et al.[22] suggested that the extension of the knee had no correlation with the Q angle by measuring the medial and lateral gliding limits of the patella during 0° and 35° flexion. In our study, the knee position of the patients was decided to be full extension and the measurements were taken accordingly.

Conclusion

In this study on patients diagnosed with gonarthrosis, we observed that the Q angle value increased with pain with a weak, but significant correlation. In addition, a weak yet statistically significant relation was also found between patients with right hand dominance and who had gonarthrosis on the right side. We think that being informed on the Q angle will contribute to both knee joint surgery and in diagnosis and treatment of the pathologies of lower extremities. On behalf of the accuracy of the studies, a mutual clinical agreement should be reached to for the Q angle measurement method and positioning, and further applications should be done accordingly.

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