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Gülşah ÜNVER, PT, PhD, Assistant Professor[1]
Hüseyin EROĞLU, PhD, Associate Professor[2]

1 *Osmaniye Korkut Ata University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Osmaniye, Turkey*
2 *Kahramanmaras Sutcu Imam University, Faculty of Sport Sciences, Department of Physical Education and Sport, Kahramanmaras, Turkey*

Correspondence (İletişim):

Gülşah ÜNVER
Osmaniye Korkut Ata University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Osmaniye, Turkey
Tel: +90554 144 06 96
E-mail: gulsahunver@osmaniye.edu.tr
ORCID: 0000-0002-3031-8322

Hüseyin EROĞLU
E-mail: eroglu1@gmail.com
ORCID: 0000-0002-6124-8187

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EVALUATION OF Q ANGLE, LOWER EXTREMITY FLEXIBILITY AND MUSCLE SHORTNESS IN WRESTLERS

ORIGINAL ARTICLE

ABSTRACT

Purpose: The aim of the present study was to determine the Q angle in wrestlers, to evaluate the flexibility and muscle shortness of the lower extremities, and to examine the relationship between the evaluated parameters.

Methods: 38 national athletes whose branch is wrestling were included in this cross-sectional study. The Q angles of the wrestlers were measured. The sit-reach flexibility test, m. quadriceps femoris and hip flexors flexibility assessment were performed for flexibility in wrestlers. In addition, a shortness test was applied to the wrestlers for m. tensor fasciae latae.

Results: According to the measurement made at the standing position, the Q angle was found to be 12.14±1.71° for the right side and 11.46±1.81° for the left side. According to the measurement made at the supine position, the Q angle was found to be 11.89±1.80° for the right side and 11.33±1.69° for the left side. According to the correlation analysis, a statistically significant relationship was found between the Q angle and the flexibility of the m. quadriceps femoris and hip flexors, between the Q angle and the shortness of m. tensor fasciae latae ($p<0.05$).

Conclusion: The Q angle values may differ depending on the right extremity, left extremity, and measurement positions. The Q angle is thought to be related to lower extremity flexibility and muscle shortness. It is recommended to consider the Q angle and related parameters together in the processes of evaluating the wrestlers and planning the training.

Keywords: Flexibility, Lower Extremity, Quadriceps Angle, Shortness, Wrestling

GÜREŞÇİLERDE Q AÇISI, ALT EKSTREMİTE ESNEKLİK VE KAS KISALIĞININ DEĞERLENDİRİLMESİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Bu çalışmanın amacı güreşçilerde Q açısının belirlenmesi, alt ekstremitelerin esneklik ve kas kısalığının değerlendirilmesi ve değerlendirilen parametreler arasındaki ilişkinin incelenmesidir.

Yöntem: Çalışmaya branşı güreş olan 38 milli sporcu dâhil edilmiştir. Güreşçilerin Q açıları ölçülmüştür. Güreşçilerde esneklik için otur-uzan esneklik testi, m. quadriceps femoris ve kalça fleksörleri esneklik değerlendirmesi yapılmıştır. Ayrıca güreşçilere m. tensor fasciae latae için kısalık testi yapılmıştır.

Sonuçlar: Ayakta duruş pozisyonunda yapılan ölçüme göre, sağ tarafın Q açısı 12,14±1,71° ve sol tarafın Q açısı 11,46±1,81° olarak bulunmuştur. Sırtüstü pozisyonda yapılan ölçüme göre, sağ tarafın Q açısı 11,89±1,80° ve sol tarafın Q açısı 11,33±1,69° olarak bulunmuştur. Korelasyon analizine göre, Q açısı ile m. quadriceps femoris ve kalça fleksörlerinin esnekliği arasında, Q açısı ile m. tensor fasciae latae kısalığı arasında istatistiksel olarak anlamlı ilişki bulunmuştur ($p<0,05$).

Tartışma: Q açısı değerleri sağ ekstremiteye, sol ekstremiteye ve ölçüm yapılan pozisyona göre farklılık gösterebilir. Q açısının alt ekstremite esnekliği ve kas kısalığı ile ilişkili olduğu düşünülmektedir. Güreşçilerin değerlendirilmesi ve antrenmanların planlanması süreçlerinde Q açısı ve ilişkili olabilecek parametrelerin birlikte dikkate alınması önerilmektedir.

Anahtar Kelimeler: Esneklik, Alt Ekstremite, Quadriceps Açısı, Kısalık, Güreş

INTRODUCTION

The Q angle is used in the kinesiological evaluation of the lower extremity. It provides information about foot, pelvis and patella positions, and tibial torsion. It is an indicator of the biomechanical alignment of the lower extremity (1,2). It is a parameter associated with the bone structure and the condition of the soft tissues of the lower extremity. The Q angle is between the line from the Spina Iliaca Anterior Superior (SIAS) to the patella and the line from the patella to the tuberositas tibiae (3,4).

Some measurement methods such as goniometric, photographing method, radiological imaging, and computerized imaging techniques are used in the evaluation of the Q angle. Since goniometric measurement is more economical, easier, and more practical than other measurement methods in the evaluation of Q angle, it is much more preferred (5,6,7).

Flexibility is the ability to move the joint along the range of motion. It can be defined as the range of motion that occurs in the joint. The conditions of muscles, tendons, ligaments, and bone structures affect flexibility. Flexibility can be evaluated with joint range of motion measurements and flexibility tests. The muscles must be of sufficient length to allow normal mobility in the joints. The purpose of muscle shortness tests is to decide on muscle length and normal joint motion (8).

Wrestling is a sport two opponents do to gain technical advantage over each other. In wrestling, two opponents try to bring one another's back to the ground within certain rules by using all their physiological and psychological powers in a special area for a certain time without using any materials or tools. Aerobic and anaerobic energy systems are used in wrestling. Factors such as strength, speed, quickness, flexibility, balance, coordination, muscular, and cardiovascular endurance affect the performance of wrestlers (9,10,11). Wrestlers may have some changes in the bone structure or soft tissues of the lower limb due to the characteristics of the wrestling branch (12,13). The performance status of the athletes is related to their anthropometric characteristics, muscle strength, and structural factors. In this context, it is very important to evaluate the Q angle associated with the m. quadriceps femoris in athletes (14,15).

When the literature was examined, it was seen that there were studies determining the Q angle, examining it in terms of some variables, and investigating its relationship with some parameters in athletes. Melekoğlu and Işın found out that the Q angle was higher in amateur football players when compared to elite football players and non-athletes (16). Mohanty and Koley found in their study that there was a significant positive correlation between right femoral anteversion, right tibial torsion, and right navicular drop with right Q angle (17). However, it has been understood that studies evaluating the Q angle for the right and left extremities in wrestlers at the supine and standing positions are not sufficient. In addition, studies examining the relationship of the Q angle with flexibility and muscle shortness of the lower extremities in wrestlers have not been found. The present study is original in these aspects. The aim of the present study was to determine the Q angle in wrestlers, to evaluate the flexibility and muscle shortness of the lower extremities, and to examine the relationship between the evaluated parameters.

METHODS

The present study is a cross-sectional one. The ethics committee approval of the study was obtained from Kahramanmaras Sutcu Imam University, Faculty of Medicine, Clinical Research Ethics Committee (Date: 18.03.2020, Session no: 2020/06, Decision no: 08). The inclusion criteria for the study were to be male, engaged in wrestling for at least 3 years, to be between the ages of 15-25 years, not to have any deformities or complaints about the lower extremities, not to have any chronic diseases, not to have any discomfort for the musculoskeletal system, and not to have any psychological or neurologic problems. Exclusion criteria for the study were to be female, be engaged in wrestling for less than 3 years, to be less than 15 or more than 25 years old, to have any deformity or complaint regarding the lower extremity, have any diagnosed chronic disease, have any disorder for the musculoskeletal system, and to have any psychological or neurologic problem. For the present study, 41 male wrestlers who met the inclusion

criteria were reached. Three of the wrestlers were excluded from the study because they did not fully agree with the measurements and evaluations. 38 wrestlers were included in the present study. Wrestlers or their parents signed the informed consent form before the study. The study was carried out in accordance with the principles of the Declaration of Helsinki. Evaluations were made between March 2022 and May 2022. Measurements, evaluations, and filling out the information form were made in the Sport Sciences Faculty laboratory of Kahramanmaras Sutcu Imam University. The Q angles of the wrestlers were measured with a goniometer at the standing and supine positions. The flexibility of the wrestlers was evaluated with the sit-reach flexibility test. Flexibility was also evaluated for the m. quadriceps femoris and hip flexors. In addition, the shortness test of the m. tensor fasciae latae was applied to the wrestlers.

Measurement of the Q angle: For measuring the Q angle while standing, the feet are kept in an upright and a neutral position. At this position, the SIAS, midpoint of the patella, and tuberositas tibiae are palpated and marked with a skin marker. The line passing through the SIAS and midpoint of the patella, the line passing through the middle of the patella and the tuberositas tibiae are determined. The acute angle between these two lines is measured with a goniometer. In the measurement at the supine position, the Q angle is measured by marking the same anatomical points (SIAS, midpoint of the patella, and tuberositas tibiae) as in the during standing measurement. For the evaluation at the supine position, the acute angle between two lines that are the same as in the standing metage is measured (3,6).

Sit-reach flexibility test: In this test, a long sitting position is taken on the floor. The person places the soles of the feet on the measuring table with the metric scale on it. The person is requested to reach forward. The farthest reachable distance is recorded in cm (18).

Flexibility assessment of m. quadriceps femoris and hip flexors: The person lies in the prone position, the leg to be tested is flexed 90° from the knee joint, and asked to raise the leg from the ground without disturbing this position. The distance between the knee and the ground is measured with a tape measure. The measurement result is recorded in cm. The pelvis is stabilized during the assessment (8).

Shortness test for m. tensor fasciae latae (TFL): The person lies in the supine position with the hips and knees extended. The untested leg is brought to the abduction position by the investigator. The other leg is brought to the side of the abducted leg (hyperabduction). If the TFL muscle is short, the tested leg will not go into the hyperadduction position (8).

In addition to the measurements and evaluations mentioned above, the wrestlers have also completed a personal information form. Questions such as age, sports age, becoming a national athlete, number of training sessions per week, and the weight they wrestled with were included in the personal information form. This form was filled out by wrestlers using the face-to-face interview technique.

Statistical analysis

After the data collection process was completed in the research, the power analysis for the current sample was made with the G*Power program (version 3.1.9.4, Franz Faul, Universität Kiel, Germany). Based on the one sample t-test, the power of the study was determined as 85% according to the parameters of 0.05 error level, 0.5 effect size, and sample number 38. For the power analysis, the primary outcome was determined as the Q angle. The SPSS program (version 25, SPSS Inc., Chicago, IL, USA) was used for the statistical analysis of the data in the present study. Descriptive statistical analyses were performed. The distribution of the data was tested in order to determine whether the tests to be used in the comparisons are parametric or non-parametric. Shapiro-Wilk test was performed to determine the normality distribution. The normality distribution was also checked with kurtosis-skewness values. Since the data were distributed normally, parametric tests were used. A dependent sample t-test was used for comparisons. Pearson correlation analysis was performed to determine the relationship between the variables. Correlation can be evaluated as follows: If r <0.2 very weak correlation or no correlation, 0.2-0.4 weak correlation, 0.4-0.6 moderate correlation,

0.6-0.8 high correlation, 0.8> very high correlation (19). The alpha value was accepted as 0.05 in all statistical analyses.

RESULTS

38 national athletes whose branch is wrestling were included in the present study. The mean and standard deviation values of some features of the wrestlers are given in Table 1.

The mean and standard deviation values of the Q angles of the wrestlers measured at the standing and supine position are given in Table 2. The comparison findings between the right and left extremities are also given in Table 2. It was found that there was a statistically significant difference between the right and left extremities for the measurement at the standing position (p=0.017). It was found that there was no statistically significant difference between the right and left extremities for the measurement at the supine position (p=0.760) (Table 2).

The flexibility evaluation findings of the wrestlers are shown in Table 3.

The distribution of wrestlers according to their TFL shortness is shown in Table 4.

Correlation findings regarding the relationship between Q angle with m. quadriceps femoris and hip flexors flexibility, and between Q angle with TFL shortness are given in Table 5. A statistically significant positive correlation was found between the left Q angle at the standing measurement and the flexibility of the left m. quadriceps femoris and hip flexors (r=0.394; p=0.014). A statistically significant positive correlation was found between the left Q angle at the standing measurement and

Table 1. The Mean and Standard Deviation Values of Some Features of Wrestlers

Some Features	Mean±SD
Age (year)	18.00±2.28
Sports age (year)	7.61±2.40
Number of workouts per week (hour)	13.21±0.99
Wrestling weight (kg)	77.39±14.63

SD: Standard Deviation, kg: kilogram

Table 2. The Comparisons of Wrestlers' Q Angle Values between Right and Left Extremities

Position and Side	Q Angle Mean±SD	t	p
Q angle at standing position (right extremity)	12.14±1.71	2.488	**0.017***
Q angle at standing position (left extremity)	11.46±1.81		
Q angle at supine position (right extremity)	11.89±1.80	0.308	0.760
Q angle at supine position (left extremity)	11.33±1.69		

SD:: Standard Deviation, t: dependent sample t-test, p: statistical significance level, *p<0.05

Table 3. The Flexibility Values of Wrestlers

Flexibility	Mean±SD
Sit-reach flexibility test (cm)	37.58±4.48
The flexibility of m. quadriceps femoris and hip flexors (right extremity) (cm)	24.43±3.14
The flexibility of m. quadriceps femoris and hip flexors (left extremity) (cm)	23.63±3.14

SD: Standard Deviation, cm: centimeter

Table 4. The Distribution of Wrestlers by TFL Shortness

TFL Shortness	n (%)
The ones with shortness (right extremity)	7 (18.42%)
The ones with shortness (left extremity)	10 (26.32%)

TFL: M. Tensor Fasciae Latae

Table 5. The Relationship between Q Angle with M. Quadriceps Femoris and Hip Flexors Flexibility and TFL Shortness

Variables		Flexibility of the left m. quadriceps femoris and hip flexors	Shortness of the right TFL	Shortness of the left TFL
Q angle (left extremity, at the standing)	**r**	0.394	0.332	0.363
	p	**0.014***	**0.042***	**0.025***

TFL: M. Tensor Fasciae Latae, pearson correlation analysis, r: correlation coefficient, p: statistical significance level, *p<0.05

the shortness of the right TFL (r=0.332; p=0.042). A statistically significant positive correlation was found between the left Q angle at the standing measurement and the shortness of the left TFL (r=0.363; p=0.025) (Table 5).

DISCUSSION

The present study aimed to determine the Q angle, evaluate the flexibility, and muscle shortness of the lower extremities in wrestlers, and examine the relationship between the evaluated parameters. The present study findings indicated that Q angle values in wrestlers may differ according to right extremity, left extremity, and measurement positions. In addition, it has been observed that the Q angle may be related to lower extremity flexibility and muscle shortness.

For the standing measurement, the mean value of the Q angle on the right extremity was 12.14±1.71° and the mean value of the Q angle on the left extremity was 11.46±1.81°. For the supine position, the mean value of the Q angle on the right extremity was 11.89±1.80° and the mean value of the Q angle on the left extremity was 11.33±1.69°. It was determined that there was a statistically significant difference between the right and left extremities in the measurement made while standing. It was found that there was no statistically significant difference between the right and left extremities for the measurement at the supine position.

In the study of Tural and Imamoğlu, the average values of the Q angle in male athletes were found to be 14.15° at the standing position and 13.10° at the supine position (20). The results of Tural and İmamoğlu's study and the present study suggest that Q angle values may be different for measurements made at standing and supine positions in athletes. Şen et al. conducted a study on athletes including wrestlers. The right Q angle values of the athletes in the standing and supine positions were higher than the left Q angle values. The Q angle in the standing position was higher than the Q angle in the supine position (21). The results of Şen et al.'s study are similar to the results of the present study. It is thought that it is important to evaluate the Q angle in athletes at different positions such as standing and supine positions. Norasteh and Bayati reported that experienced freestyle wrestlers had a higher degree of Q angle in the dominant leg (22). Akınoğlu et al. found that the right-side passive Q angles of the athletes were lower than the left side, and the active Q angles of both sides were similar to each other (1). This result obtained from the study of Akınoğlu et al. differs from the results of the present study. In the study of Erdağı, the Q angle was evaluated while individuals were at the supine position and m. quadriceps femoris was in a passive position. It was determined that the left quadriceps femoris angle values of weightlifters were greater than the right quadriceps femoris angle values (23). This result of Erdağı's study does not show similarity in terms of the result that there is no significant difference between the right Q angle and the left Q angle in wrestlers according to the values of the measurement made at the

supine position in the present study. Bayraktar et al. carried out a study on a total of 1239 people, including 474 football players and 765 sedentary boys between the ages of 9-19. Right and left Q angle values were not statistically significant in both groups (24). Bayraktar et al.'s study can be evaluated as parallel to the results of the present study for the supine position. Evaluation of the Q angle for both lower extremities in athletes may be important for lower extremity biomechanics. It should not be ignored that the Q angle values for the right and left lower extremities can be transferred according to the measurement positions. It is thought that specifying the Q angle values in wrestlers according to the measurement positions and separately according to both lower extremities will gain the perspective in terms of biomechanics.

In the present study, the flexibility of the wrestlers was found to be 37.58±4.48 cm according to the results of the sit-reach flexibility test. Flexibility values of m. quadriceps femoris and hip flexors were found 24.43±3.14 cm for the right side and 23.63±3.14 cm for the left side. In addition, it was determined in the present study that there were 7(18.42%) wrestlers with TFL shortness on the right side and 10 (26.32%) wrestlers with TFL shortness on the left side.

In the study of Kaya et al., a total of 40 wrestlers, 20 freestyle and 20 Greco-roman participated. In the study, flexibility (sit-reach) values were measured as 37.45±4.51 cm for the national freestyle wrestling team and as 32.70±6.94 cm for the Greco-roman wrestling national team (25). Aydos and Koç evaluated flexibility with the sit-reach flexibility test in their study and found the flexibility of 17–18-year-old Greco-roman youth national team wrestlers as 31.30±6.04 cm (26). Campos et al. evaluated the flexibility of Marajoara wrestlers with the sit-reach flexibility test and the flexibility values were found 33.25±8.40 cm (27). When the studies in the literature and the present study are examined, it is thought that the structural and biomechanical characteristics of the lower extremities, the scope of their training, age range, wrestling style are effective in the flexibility results of wrestlers.

According to the correlation findings in the present study, a positive, weak correlation was found between the left Q angle at the standing measurement and the flexibility of the left m. quadriceps femoris and hip flexors. In other words, as the Q angle values increased, the flexibility of the m. quadriceps femoris and hip flexors also increased. A positive, weak correlation was found between the left Q angle at the standing measurement and the shortness of the right TFL. A positive, weak correlation was found between the left Q angle at the standing position and the shortness of the left TFL. It has been found that muscle flexibility and shortness which is an important parameter for athletes are related to the Q angle. This result suggests that the conditions of the joints and soft tissues may be affected by the Q angle.

In the study of Eliöz et al., it was found that there was a negative and weak relationship between the Q angle and the length of the femur (14). Hazar et al. conducted a study on 125 athletes who regularly train and participate in sports competitions. In their study, it was determined that those with high Q angle values had a decrease in leg strength and balance values (28). In the study of Akınoğlu et al., the relationship between the Q angle and quadriceps muscle strength of all athletes was examined. In their study, it was determined that there was a statistically significant negative and very weak relationship between the passive Q angle on the right side and the eccentric strength of the knee extensors at angular velocities of 60º/sec and 180º/sec (1). Minoonejad et al. found in their study that there was a significant difference in Q angle between premier league futsal players with and without hamstring tightness. In Minoonejad et al.'s study, the Q angle was found to be significantly higher in futsal players with hamstring tightness when compared to futsal players without hamstring tightness (29). Q angle may be related to parameters such as flexibility, muscle shortness, muscle strength, balance, and anthropometric characteristics. In this direction, it is important to examine the Q angle in athletes together with some parameters and anthropometric features.

The values of the Q angle may differ in athletes. Some factors are effective in the difference of the Q angle. Among the factors that can cause change are bone structures, soft tissues, right or left ex-

tremity, age, the strength of the m. quadriceps femoris, flexibility, gender, lower extremity length, the length of the femur, the width of the pelvis, an increased femoral anteversion angle, tibial rotation, varus-valgus deformities, engaging in sports, sports branch, and daily living habits. In addition, the value of the Q angle may differ depending on the measuring positions (standing position or supine position). Since it is important in the evaluation of knee functions in terms of participation in sports, it may be useful to evaluate the Q angle not only at the supine but also standing position. There may be a relationship between the Q angle and some factors such as flexibility, muscle shortness, muscle strength, balance, and anthropometric characteristics among athletes. It is important to evaluate the Q angle together with the parameters that are thought to be related. It is thought that the Q angle value and the parameters that are thought to be related should not be generalized and should be interpreted specifically for the age, branch, gender, and sports age of the athletes. The contributions of the results of the present study to future scientific studies and clinical applications may be in the scope of using the values obtained from the Q angle as reference values, knowing the factors that will affect the Q angle, assessing malalignment in the lower extremity, and providing predictions of risk factors for sports injuries. Conducting studies that examine the Q angle and the factors affecting the Q angle in athletes according to their characteristics will contribute to the field of sports sciences.

The present study has some limitations. Only male wrestlers were included, but females were excluded as it was thought that there would not be enough female participants to make comparisons between the genders. In addition, wrestlers were not categorized according to their wrestling style.

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Conflict of Interest: There is no conflict of interest.

Informed Consent: Written informed consent was obtained from the individuals participating in the study and their parents.

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Author Contributions: Concept – GÜ, HE; Design – GÜ; Supervision – GÜ; Resources and Financial Support – GÜ, HE; Materials – GÜ; Data Collection and/or Processing – GÜ, HE; Analysis and/or Interpretation – GÜ, HE; Literature Research – GÜ; Writing Manuscript – GÜ, HE; Critical Review – GÜ, HE.

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