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Investigation of the Relationship of Q Angle and Stork Balance Stand Test With Somatotype in Healthy Young Individuals

Investigation of the Relationship of Q Angle and Stork Balance Stand Test With Somatotype in Healthy Young Individuals

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Abstract

Aim: The Q angle, which is an important marker for assessing lower extremity status in all skeletal evaluations, is also a parameter influencing balance. The aim of this study is to investigate the relationship of patellafemoral angle (Q angle) and stork balance stand test (SBST) with somatotype in healthy young subjects.
Material and Methods: Q-angle, SBST and somatotype measurements of 191 healthy young individuals (105 male, 86 female) were made within the context of the study. Somatotype measurement was made with Heath-Carter formula. Somatotype calculations were made with “Somatotype for Windows 1.2.6 Trial Version” program.
Results: In the 191 individuals who participated in the study, 7 different somatotypes were found as endomorphic mesomorph (71), mesomorph-endomorph (27), balanced ectomorph (15), central (17), balanced mesomorph (24), mesomorphic endomorph (19), mesomorphic ectomorph (18). According to the Kruskal Wallis H Test conducted, it was found that there were no statistically significant differences in Q angle and SBST of each somatotype found in males and females (p>0.05).
Conclusion: It was found that there were no statistically significant associations between SBST and Q angle scores and somatotypes assessed in our study. It is thought that since there are limited numbers of studies in literature conducted by using detailed somatotype character analysis, our study will contribute to making up the deficiency in this field.

Keywords: Stork balance stand test, Q angle, balance, somatotype

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Amaç: Tüm iskelet değerlendirmelerinde alt ekstremite durumunu değerlendirmek için önemli bir belirteç olan Q açısı dengeyi de etkileyen bir parametredir. Bu çalışmada; sağlıklı genç bireylerde patellafemoral açı (Q açısı) ve stork balance stand testinin (SBST) somatotip ile ilişkisinin incelenmesi amaçlandı.
Materyal ve Metod: Çalışma kapsamında üniversite öğrencisi 105’si erkek, 86’sı kadın toplam 191 sağlıklı genç bireyin Q açısı, SBST ve somatotip ölçümleri yapıldı. Somatotip ölçümü Heath-Carter formülü ile yapıldı. Somatotip hesaplamaları “Somatotype for Windows 1.2.6 Trial Version” programı ile yapıldı.
Bulgular: Çalışmaya katılan 191 bireyde endomorfik mezomorf (71), mezomorf-endomorf (27), dengeli ektomorf (15), merkez (17), dengeli mezomorf (24), mezomorfik endomorf (19), mezomorfik ektomorf (18) olmak üzere 7 farklı somatotip tespit edildi. Yapılan Kruskal Wallis H Testine göre erkek ve kadınlarda belirlenen her bir somatotipte Q açısı ve SBST’de istatistiksel açıdan anlamlı fark olmadığı belirlendi (p>0.05).
Sonuç: Çalışmamızda değerlendirilen SBST ve Q açısı skorları ile somatotipler arasında istatistiksel olarak anlamlı ilişki bulunmadığı belirlendi. Literatürde ayrıntılı somatotip karakter analizi kullanılarak yapılmış oldukça sınırlı sayıda çalışma olduğu, çalışmamızın literatürde bu alanda görülen eksikliğin giderilmesini sağlayacağı düşünülmektedir.

Anahtar Kelimeler: Stork balance stant test, Q açısı, denge, somatotip

INTRODUCTION

The quadriceps femoris angle, also known as the patellafemoral angle (Q angle), is defined as the angle between the line between the anterior superior and the midpoint of the patella and the line joining the patella midpoint and the tuberositas tibia (1). In addition to being used in assessing patellafemoral mechanism in clinic, it is also an important marker used to determine lower extremity status in all skeletal evaluations (2). It is thought

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that when the Q angle exceeds the 15-20 degree limit, it causes disruption of the knee extensor mechanism and causes patellofemoral pain with increasing tendency of the patella to shift laterally. Disturbances in biomechanics of the knee joint and therefore of the lower extremities bring about problems related with balance. In the literature review conducted, it can be seen that Q angle is affected by physical performance and especially increased quadriceps-hamstring ratio (3). Postural control and balance are the ability to maintain the body's center of gravity over the base of support; it is a basic requirement for independent mobility in daily life (4) The maintenance of this complex process depends on the vestibular system, age, pain, vision, body shape, body composition, visual-spatial perception, tactile input, agility, proprioception, and the musculoskeletal and neuromuscular systems (3). Any insufficiency of this complex may result in imbalance. From this point of view, the idea arises that Q angle can be associated with somatotype, which is a detailed body composition evaluation method.

Somatotype is a genetic marker that identifies the physical and somatic health of individuals relatively and it is a method by which body composition is expressed regardless of body size and shape. Evaluations made by using anthropometric measurements allow the description of a person's physical structure. When evaluating the morphofunctional characteristics of individuals, evaluating the somatotype is important when combined with clinical anthropometric measurements to obtain important results about the individual (5-7).

In the literature, it is seen that somatotype is determined only as endomorphic, mesomorphic and ectomorphic in studies conducted about muscle strength of different somatotypes and balance, and our study is different from other studies based on the fact that 13 subgroups of somatotype were examined in our study and the assessments were made on 7 subgroups found.

The hypothesis of this study is that Q angle can be influenced by body composition and this situation can be related to balance. In the literature review conducted, no studies were found which correlated Q angle and balance issues with somatotype character analysis. The aim of this study is to investigate the relationship between Q angle and SBST and somatotype in healthy young individuals and to contribute to the literature from this perspective.

MATERIAL AND METHODS

This study was conducted with the 2019/5-17 numbered permission of Local Clinical Researches Ethical Board. A written informed consent was obtained from each participant. The study was conducted in accordance with the principles of the Declaration of Helsinki.

A total of 191 healthy sedentary volunteers (105 male, 86 female) who were not engaged in any sport, did not do active sports in the last 6 months and who did not have any orthopedic, neurological, systemic and cognitive problems participated in the study.

Data Collection Process

Sociodemographic data and measurement results of each participant informed about the study were recorded.

Age, Height, Weight, and Body Mass Index Measurements

The patients' ages were calculated in years, and their heights were measured in cm while they stood barefooted using a steel stadiometer with a precision of 0.1 cm. Their weights were measured in kg while they stood barefooted without metal using a Tanita BC Segmental Body Analysis System (Tanita Corporation, Tokyo, Japan). The body mass indexes (BMIs) were calculated using the following formula: weight (kg)/height (m2) (8).

Anthropometric measurements

For the triceps skinfold (SF), the measurement was taken, when the participant was on foot, hanging his arms freely to the sides without contracting. The measurement was taken over and from the midpoint of the triceps muscles behind the arm. For the subscapular SF, the measurement was taken by removing the skin and the underlying skin layer by complying with the natural folds of the skin, right under the scapulas of the participants and the thumb, index, and middle fingers of the left hand. For the supraspinale, the measurement was made, when the participant was standing over the ileum bone and the line on which midaxillary line was. For the calf SF, the measurement was made by removing some skin from the medial area of the leg. For the elbow width, the arm was pulled slightly to the front and the palm of the hand was bent up 90° from the elbow. The measurement was taken from between the epicondylus lateralis and epicondylus medialis points of the humerus. For the knee width, the distance between the most topped two points of inner and outer sides of articulatio genus was measured. For the arm circumferences, the measurement was taken from the most topped areas of the midpoint between acromion and olecranon. For the calf circumferences, the tape was wrapped vertically to the long axis of the leg at maximum hip thickness and the measurement was taken (9,10).

Calculation of somatotypes

Somatotype (1.2.6 trial) program designed by Heath-Carter formula was used for the calculation of somatotypes and for somatotype drawings. Anthropometric measurements such as height and weight, triceps, subscapular, supraspinale, and calf SF thickness, knee and elbow width and arm and calf circumferences were taken from each student in line with the techniques set forth by the International Biological Program (IBP) and International Society for the Advancement of Kinanthropometry (ISAK) to determine somatotype. The SFs were measured by using the baseline SF caliper (model: 12-1110) (10,11). Height and knee and elbow widths were measured using the Harpenden anthropometer set (Holtain Ltd., Crymych, Dyfed, Wales, UK). Weights were measured with Tanita body composition analyzer (BC-418 MA) device (Tanita Europe BV, Amsterdam, Netherlands) (12). Arm and calf circumferences were measured using the baseline circumference (10,11,13).

Balance measurement

Static balance was assessed utilizing the SBST protocol. To perform the SBST, participants stood with their opposite foot against the inside of the supporting knee and both hands on the hips. On the command, participants raised the heel of their foot from the floor and attempted to maintain their balance as long as possible. The trial ended if the participant either moved his hands from his hips, the ball of the dominant foot moved from its original position, or if the heel touched the floor. This test was carried out on the dominant leg acting as the standing leg. The test was timed (s) using a stopwatch. The recorded score (duration in seconds) was the best of three attempts. Previous test–retest reliability scores for balance measures from our laboratory with a similar pediatric population have been high (14,15).

Assessment of the Q angle

The Q angle was measured from the right knee on the horizontal examination table with the subject in the supine position and the m.quadriceps femoris relaxed with both lower extremities fully extended. Measurements were made with Baseline 360 ° goniometer. Spina iliaca anterior superior, midpoint of the patella and tuberositas were marked on the tibia, with the exact midpoint of the goniometer coinciding with the midpoint of the patella. One arm of the goniometer was aligned to the anterior superior point of the spina iliaca and the other arm was aligned to the point of the tuberositas tibia and the Q angle was recorded in degree (16).

Statistical Analysis

IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA) was used for statistical analysis. Kolmogorov-Smirnov test was used to find out whether the data were normally distributed and it was found that they were not. The data were given as median (min-max). Kruskall Wallis H test was used to compare the parameters used for demographic and somatotype measurements. In terms of somatotype in men and women, Kruskall Wallis H test was used to compare Q angle and SBST for different somatotypes.

Mann-Whitney U test was used to compare the Q-angle and SBST in terms of gender in the same somatotype between men and women. p <0.05 was considered statistically significant.

RESULTS

A total of 191 individuals (105 male, 86 female) participated in this study. Based on the somatotype analysis, 7 different somatotypes were found in the participants. The somatotypes and numbers found in 105 male participants were as follows; endomorphic mesomorph (36), mesomorph-endomorph (15), balanced ectomorph (8), central (10), balanced mesomorph (16),

Tablo 1. The distribution of somatotypes and median (min-max) values of parameters used in somatotype calculations of male participants in the study

Variables	Endomorphic Mesomorph	Mesomorph Endomorph	Balanced Ectomorph	Central	Balanced Mesomorph	Mesomorphic Endomorph	Mesomorphic Ectomorph	p
Age	21 (20-23)	21 (20-25)	20.5 (19-21)	21 (20-22)	21 (20-26)	21 (20-22)	21.5 (20-24)	.385
Height	177.5 (160-194)	175 (164-188)	182 (169-190)	178 (174-187)	179 (170-187)	177 (168-185)	177 (168-185)	.149
Weight	79 (63.1-91.7)	73.9 (61.1-84.9)	59.4 (52.2-70.1)	65 (58.3-76.7)	73.4 (61.2-87.7)	77.7 (70.1-95.9)	59.4 (53.8-86)	.000
BMI*	24.8 (21.8-29.6)	23.6 (21.5-27.2)	18 (15.8-20.1)	20.7 (19-22.2)	23.4 (20-25.9)	26.1 (23.4-28.3)	19.2 (17.5-25.7)	.000
Triceps ST**	14 (3-17)	18 (9-25)	11 (3-14)	12 (7-18)	6 (3-14)	18.5 (11-28)	5.5 (3-17)	.000
Subscapular ST	15.5 (6-25)	17 (12-26)	11 (8-16)	14.5 (11-19)	10.5 (6-15)	22.5 (15-30)	9 (6-20)	.000
Supraspinale ST	13 (7-31)	18 (10-30)	10 (5-18)	12 (5-14)	8.5 (4-20)	23.5 (15-30)	8 (5-20)	.000
Calf ST	16 (7-24)	13 (5-22)	9.5 (7-15)	13.5 (8-22)	10 (6-16)	13.5 (29.5-35.5)	9 (6-19)	.002
Arm Cir***	33 (27.5-40)	32.5 (23-41)	27.2 (25-30.5)	30 (25-33)	32.2 (29-37)	31.7 (29.5-35.5)	28 (25-34)	.000
Calf Cir	38 (30.5-46)	36.5 (32-41)	32.5 (30-35)	34.5 (33-42)	36.5 (32-41)	38 (34.5-41.5)	33.7 (28-38)	.000
Elbow width	8.1 (6.4-9.5)	7.9 (7.1-8.5)	7 (5.7-8.1)	7.4 (6.6-8.5)	7.8 (7-9)	7.5 (6.9-8.6)	7.3 (6-8.8)	.006
Kneee width	10.1 (8.8-15)	9.2 (7.7-10.2)	8.6 (7.8-10)	9.3 (8.4-9.7)	10 (7.6-11.2)	8.7 (7.9-9.7)	9.8 (8.8-10.8)	.000
Endomorpy	4 (1.6-5.6)	5.1 (3.1-7.2)	3 (1.4-4.4)	3.7 (3-4.4)	2.3 (1.6-3.6)	6 (4.4-7.1)	1.8 (1.5-4.7)	.000
Mesomorphy	6.3 (4.5-9.9)	5.1 (3.6-6.8)	1.9 (1-3.4)	3.9 (3.5-4.4)	5.8 (3.7-8)	4.6 (2.9-5.4)	3.8 (2.1-4.3)	.000
Ectomorphy	1.8 (0.4-3.3)	1.9 (0.8-3.3)	5.3 (4.2-7.1)	3.6 (3.2-4.6)	2.2 (1.4-4.1)	1.4 (0.6-2.2)	4.5 (4-5.5)	.000

*Body Mass Index **ST: Skinfold thickness ***circumference mesomorphic endomorph (10), mesomorphic ectomorph (10). The somatotypes and numbers found in 86 female participants were as follows; endomorphic mesomorph (35), mesomorph-endomorph (12), balanced ectomorph (7), central (7), balanced mesomorph (8), mesomorphic endomorph(9), mesomorphic ectomorph (8). Table 1 and Table 2 show the comparison of parameters used in the somatotype calculation of male and female participants.

Table 3 shows the comparison of the right and left Q angle for each somatotype by gender.

Table 4 shows the assessment of right and left SBST scores of all somatotypes in terms of gender. Table 5 shows the results for Q angle and SBST comparison of somatotypes.

Tablo . The distribution of somatotypes and median (min-max) values of parameters used in somatotype calculations of female participants in the study

Variables	Endomorphic Mesomorph	Mesomorph Endomorph	Balanced Ectomorph	Central	Balanced Mesomorph	Mesomorphic Endomorph	Mesomorphic Ectomorph	p
Age	21 (19-26)	21 (20-22)	21 (20-22)	20 (20-22)	21 (20-25)	21 (20-22)	21 (20-22)	.700
Height	163 (155-175)	161.5 (150-175)	167 (163-177)	160 (150-168)	161 (157-172)	163 (157-170)	169 (156-172)	.181
Weight	62.3 (53.2-91.3)	56.6 (48.4-64.9)	52.7 (42.6-56.9)	49.1 (43.7-52.3)	57.9 (46.8-64.6)	54.4 (45.1-68.4)	52.3 (37.6-58.7)	.000
BMI*	23.5 (20.4-30.3)	21 (20-22.7)	18.8 (15.5-19.8)	19.1 (18.5-19.4)	20.3 (18.3-26.2)	20.4 (18.3-25.1)	18 (15.5-20.1)	.000
Triceps ST**	10 (6-21)	15 (11-24)	8 (5-10)	10 (6-17)	7.5 (4-15)	13 (12-27)	5 (4-7)	.000
Subscapular ST	13 (9-20)	15.5 (10-26)	9 (8-13)	14 (8-16)	10 (7-19)	15 (13-21)	7.5 (6-9)	.000
Supraspinale ST	12 (6-22)	17.5 (15-24)	7 (5-10)	10 (9-15)	8 (6-20)	15 (10-17)	6.5 (4-10)	.000
Calf ST	13 (8-22)	27 (23-30)	9 (6-20)	13 (9-18)	10 (7-19)	18 (14-26)	9 (7-13)	.000
Arm Cir***	28 (24-35)	35 (33-36)	23 (20-26)	23 (21-26)	25.7 (23-29)	25 (22-28.5)	24.5 (22-25)	.000
Calf Cir	37 (33-44)	7.2 (6.3-8.2)	30 (29-36)	32 (29-35)	34.5 (32-39)	32 (28-38)	32.5 (27-36)	.000
Elbow width	7.3 (6.5-8.7)	9.2 (8.5-10.5)	6.4 (5.3-7)	6.2 (5-6.3)	6.9 (6.5-7.4)	6.7 (5.5-8)	6.3 (5.7-7.6)	.000
Knee width	10.2 (8.6-12.8)	4.6 (4.4-7.4)	8.8 (7.7-9.5)	9.2 (8.7-9.7)	9.1 (8.5-11.2)	9.4 (8.6-11)	8.8 (7.7-10.3)	.000
Endomorphy	3.8 (2.3-6)	4.9 (3.9-7.6)	2.5 (1.9-3.2)	4 (2.6-4.3)	2.7 (2.1-3.2)	4.7 (3.8-6)	1.9 (1.5-2.6)	.000
Mesomorphy	6.3 (4.2-10.5)	2.5 (0.1-3.7)	2.2 (2-2.5)	3.3 (2.9-3.8)	4.6 (4.2-6.6)	3.8 (1.9-5.2)	3.2 (2.6-3.6)	.000
Ectomorphy	1.3 (0.1-3.3)	9 (7-14)	4.3 (3.3-6.2)	3.6 (2.6-4.3)	2.9 (1.7-3.9)	2.9 (1.1-3.7)	4.7 (3.6-5.5)	.000

*Body Mass Index **ST: Skinfold thickness ***circumference

Table 3. Assessment of right and left Q angle of somatotypes in terms of gender

Somatotype	Right Q		p	Left Q		p
	Male	Female		Male	Female	
Endomorphic Mesomorph	10° (7°-14°)	9° (7°-16°)	.022	10° (8°-14°)	10° (7°-17°)	.058
Mesomorph Endomorph	10° (5°-11°)	9° (7°-14°)	.131	10° (6°-13°)	9.5° (8°-13°)	.403
Balanced Ectomorph	10° (9°-12°)	10°(4°-13°)	.536	11.5° (9°-13°)	11° (4°-12°)	.281
Central	10° (9°-14°)	10° (8°-11°)	.768	11° (9°-14°)	10° (9°-13°)	.859
Balanced Mesomorph	10° (5°-14°)	10° (9°-12°)	.928	11° (6°-13°)	11° (10°-13°)	.214
Mesomorphic Endomorph	10.5°(7°-15°)	10° (9°-13°)	.905	10.5° (8°-15°)	10° (8°-14°)	.968
Mesomorphic Ectomorph	11° (8°-13°)	9.5° (3°-13°)	.173	12° (8°-13°)	10.5° (3°-13°)	.173
p	.643	.455	p	.536	.496	

Table 4. Assessment of right and left SBST scores of somatotypes in terms of gender

Somatotype	Right Q		p	Left Q		p
	Male	Female		Male	Female	
Endomorphic Mesomorph	20 (2-178)	35 (4-360)	.104	24 (2-141)	22 (4-430)	.927
Mesomorph Endomorph	22 (1-75)	31 (2-127)	.581	27 (3-81)	42 (1-163)	.456
Balanced Ectomorph	22.5 (9-152)	41 (14-65)	.613	42 (4-211)	51 (19-76)	.536
Central	22.5 (8-86)	59 (22-77)	.513	19 (3-202)	61 (21-69)	.165
Balanced Mesomorph	28 (13-82)	54.5 (31-104)	.019	25 (4-76)	34.5 (17-120)	.177
Mesomorphic Endomorph	24.5 (7-87)	13 (4-129)	.356	9 (3-83)	19 (3-67)	.661
Mesomorphic Ectomorph	33.5 (2-49)	30 (13-93)	.965	19.5 (2-35)	33.5 (10-62)	.016
p	.678	.270	p	.699	.183	

Table 5. Kruskall Wallis H test results for Q angle and SBST comparison of somatotypes

Gender	Right Q	Left Q	Right SBST	Left SBST
Male	.643	.536	.678	.699
Female	.455	.496	.270	.183

DISCUSSION

The aim of this study is to investigate the relationship of Q-angle and SBST with somatotype in healthy young individuals. No statistically significant difference was found in Q angle and SBST results for 7 different somatotypes (p>0.05).

The muscle strength required to gain and maintain static and dynamic balance varies according to the type of posture, physical characteristics of the person, and body composition. Q angle is an important mechanism that has an important place in the balance of musculoskeletal system. Changes in the Q angle may cause deterioration of the extensor mechanism, resulting in knee joint hypermobility and patellar instability, leading to balance problems (17).

In a study by Bayraktar et al., it was reported that the decrease in Q angle values is higher in active individuals doing physical activity when compared with sedentary individuals. These findings have been associated with developmental differences by researchers, without ignoring other biomechanical factors such as pelvic width and femoral length and it has been reported that a decrease occurred in Q angle due to muscle tone and strength increase in thigh muscle group (18). In another study, it was reported that the Q angle was related to the force exerted on the patella and to the lateral by the m.quadriceps femoris, thus lower Q angles could be encountered in athletes (19). As stated by Hahn and Foldspang, high force and muscle tone of m. quadriceps femoris muscle group decreases Q angle (1).

Thus, as the Q angle decreases, that is as the angle becomes narrower, the effect of the transmitted muscle strength will increase. In our study, Q angles of somatotypes were evaluated in young sedentary individuals and no statistically significant difference was found. This can be due to the fact that the average age of the individuals in the study was quite young. In a study examining the factors affecting posture and musculoskeletal conditions of normal and overweight individuals, it was concluded that Q angle was not affected by body mass index (BMI). In our study, it was concluded that the BMI of all somatotypes were statistically significantly different from each other and Q angle was not affected by somatotypes and BMI (20).

In the literature review conducted, somatotypes were classified as endomorphic, mesomorphic, ectomorphic in a study which aimed to determine the relationship between Q-angle and somatotype and it was reported that mesomorphic individuals had statistically lower Q-angle (21). In a study conducted by Ibikunle et al., it was reported that there were statistically significant differences in Q angle and other anthropometric measurements of individuals who were found to have endomorphic, mesomorphic, ectomorphic somatotypes and that individuals with endomorphic somatotype had high Q angle when compared with other somatotypes (22).

In a study which assessed the effect of somatotype on balance, quiet standing balance was tested using a force platform. It was reported that the balance scores of mesomorphic individuals were statistically superior to other somatotypes. In another study, which evaluated the relationship between static balance and somatotype, it was concluded that the balance scores of mesomorphic individuals were statistically better than those of other somatotypes. In our study, it found determined that there was no statistically significant relationship between balance and Q angle scores and somatotypes. The fact that 4 of the 7 different somatotypes we evaluated in the study were close to the mesomorphic somatotype character may have caused this result (23, 24). In our study, no significant relationship was found between somatotype and Q angle and balance. It can be seen that there is a limited number of studies in the literature using detailed somatotype character analysis, and there are no studies evaluating the relationship between Q angle, balance and somatotype among these studies. Studies conducted with different age groups and larger populations will help to overcome the lack of literature in this area.

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