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EVALUATION OF CHANGES IN Q ANGLE DURING ISOMETRIC CONTRACTION AND RELAXED STATE OF QUADRICEPS AMONG FEMALES IN SUPINE AND STANDING POSITIONS

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Abstract

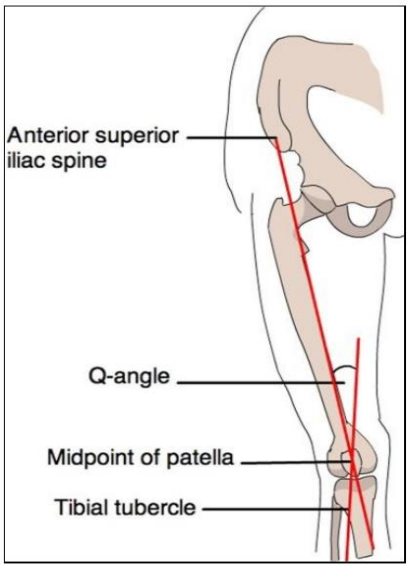
Background: Nowadays many young active females are diagnosed with anterior knee pain or patellofemoral pain disorder. Q angle is an essential parameter to check the alignment of the patella within the quadriceps muscle. Higher Q angle may cause patellofemoral pain which may lead to patellar subluxation. Previous studies supports that there is a decrement in Q angle during maximal isometric quadriceps contraction. Thus, the purpose of this study is to evaluate Q angle value among young females in both supine and standing.

Method: 66 subjects participated in this study who have no significant history of any knee pathology. The Q angle was measured in relaxed state of quadriceps and during isometric contraction with knee in full extension on right and left side in both supine and standing. The Q angle was measured using universal goniometer. Data was collected from each subject and analyzed using SPSS software 28.00.

Results: The result of this study shows that there was a significant decrease in q angle values during relaxed state and isometric contraction ofquadriceps in both supine and standing positions. While there was no significant difference in Q angle values when both the positions were compared.

Conclusion: The study concludes that the Q angle decreases with isometric quadriceps contraction on both the sides in supine and standing positions but there was no difference in q angle values in both body positions.

Key words: Q angle, goniometer, isometric quadriceps contraction, supine and standing positions.

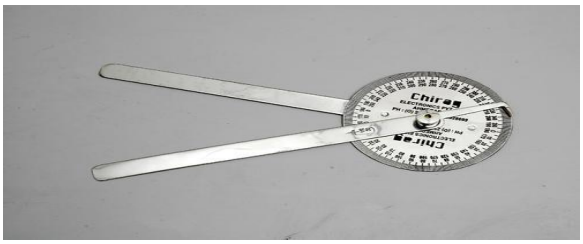


INTRODUCTION

Quadriceps femoris angle, which is also known as Q angle or patellofemoral angle, has been defined as the angle between a line drawn to the center of patella from anterior superior iliac spine (ASIS) and another one drawn from the center of patella to tibial tubercle center.(1) It is a clinical measurement used to measure knee alignment with respect to the hip, femur and tibia, and to evaluate the patella alignment.(7)

Normal values of Q angle have been found to be 11.3–20.3 for women and 8.2–14.2 for men with knees in full extension.(2) The Q angle is measured using a standard universal goniometer.

Since the patella lies within the tendon of quadriceps femoris complex, the magnitude of Q angle varies with strength and muscle tone of the knee. Livingstone LA et al demonstrated that though the 3 skeletal



landmarks define the Q angle yet the location of the patella within the quadriceps tendon leads to alteration in the magnitude of the angle when the characteristics of the quadriceps musculature changes.[2,6] The Q angle shows an inverse relationship with quadriceps strength, as the smallest the angle the greater the force produced by the quadriceps.[7] Therefore a higher Q angle (greater than 20°) may influence the biomechanics of knee joint and patella causing patellar malalignment and quadriceps weakness that may lead to patello-femoral pain disorder.[3]

The patellofemoral pain disorder or PFPD is an articular disorder manifested by pain in the anterior portion of the knee and a functional deficit that compromises the daily activities.[4] It constitutes 25% of the injuries compromising the knee, affecting mainly young 15-25 years old females.[4] This is possibly due to an increased pelvic width, shorter femur length, or femoral neck ante version.[8] Hence the Q-angle is often used, to identify contributing factors to PF pain/instability and also in patients with high risk of the disorder.[5]

Emami et al justified the fact that patients with patellofemoral pain are associated with patellar misalignment and quadriceps weakness which are more commonly seen in women. H Huberti also proved that tendofemoral contact of Q angle at higher angles of flexion carries the significant fraction of the total contact force of the patella. Therefore, both increase and decrease in Q angle lead to more non uniform pressure distribution with higher peak stresses and unloading of other areas. [6]

The value of Q angle may vary according to the patients' gender, the state of contraction of the quadriceps and the position adopted by the patient, standing or supine.[7] Thus the present study is conducted to analyze the difference between the quadriceps angle in young females in two different examination situations, having the quadriceps relaxed and in isometric contraction both in standing and supine.[6]

MATERIALS AND METHODOLOGY

Study design: Observational study
Study setup: Dr. Ulhas Patil College of Physiotherapy
Study duration: 6 months
Sample size: 66
Study population: Young healthy females of age group 18-25 yrs

SELECTION CRITERIA

Inclusion criteria:

Female subjects
Age group between 18-25yrs
Subjects with informed consent form

Exclusion criteria:

Recent history of knee pathological conditions
Any structural hip, knee, ankle deformity
Traumatic /surgical knee records
Obese individuals
Limb length discrepancy

Equipments required:

Goniometer
Tapes or marker
Paper and pen

PROCEDURE

To conduct the following study permission is taken from Dr. Ulhas Patil college of Physiotherapy, Jalgaon. Ethical clearance was obtained from institutional ethical committee. Subjects were screened according to the Inclusion and Exclusion criteria. The informed consent was obtained from selected participants & procedure was explained. Initially, the demographic data that is Name, Age of the subject was assessed. Then the Q angle measurement was taken with knee in relaxed and with isometric quadriceps contraction in supine and standing positions of right and left side.

Measurement of Q angle:

- The 66 subjects are selected using the simple random sampling technique from Dr. Ulhas Patil College of Physiotherapy, aged between 18-25 yrs.
- First data collection was taken from each subject.
- The Q angle measurement was taken in standing and supine with having the knee in relax and contract on the both sides.
- The Q angle was measured using a universal goniometer.
- First small tapes or markers were applied to the anterior superior iliac spine, midpoint of patella and middle of tibial tubercle.
- The midpoint of patella is determined by lines intersecting from lateral to medial and from superior to inferior of patella.
- This point is marked first with quadriceps relaxed and then with the quadriceps contracted isometrically.
- In both the positions, i.e., standing and supine, the subjects faced forward with the foot in neutral.
- The goniometer with lengthened stationary arm is aligned over ASIS, the fulcrum over the midpoint of patella and the moving arm parallel to the tibial tuberosity.
- The measurements were taken first with quadriceps relaxed and then during isometric quadriceps contraction in standing and supine positions.
- The values of Q angle were noted down for further analysis and interpretation.

Fig 1. Q angle in supine

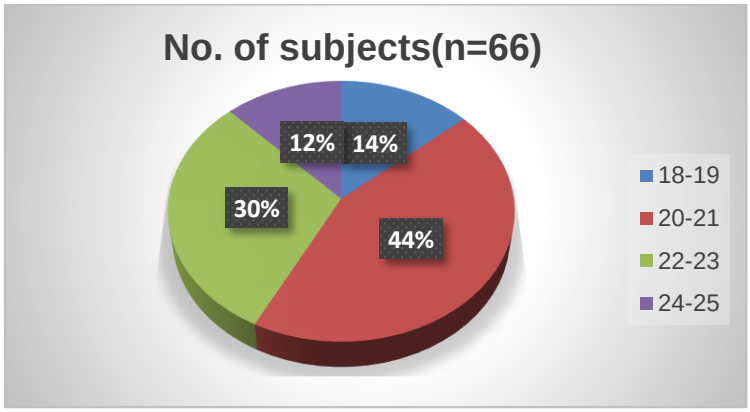
Fig 2. Q angle in standing

RESULT AND DATA ANALYSIS

- The collected Data i.e., Q angle values are quantitative in nature.
- Hence, Paired and Unpaired t test was applied to find whether there are changes in Q angle during isometric quadriceps contraction in supine and standing
- All the Statistical Analysis was performed using the Statistical Software SPSS 28.00
- All the tests were performed and were considered significant at $p<0.05$.

Table 1: Age wise distribution of subjects

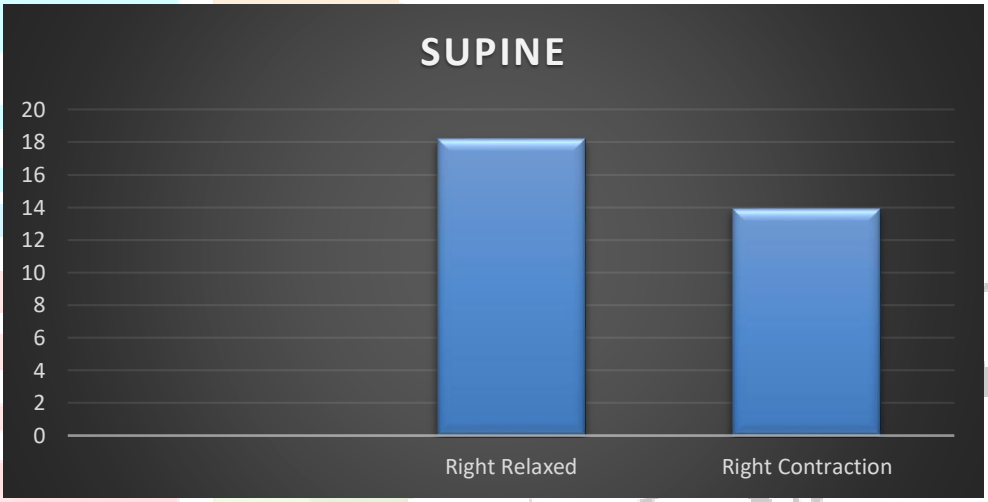
Age in years	No of subjects (n=66)
18-19	9
20-21	29
22-23	20
24-25	8



Inference- The pie diagram shows age wise distribution . In our study, out of 66 young females ,9 subjects were between the age group 18-19, 29 subjects were between 20-21, 20 subjects between age group 22-23 whereas 8 subjects were between 24-25 years of age.

Table 2: Right Q angle during quadriceps relaxed and during isometric contraction in supine

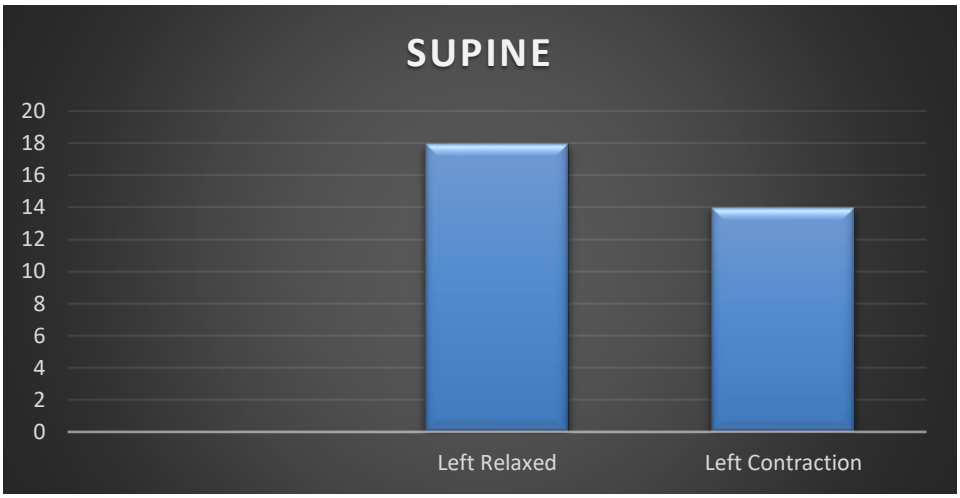
No.	Variables	Mean	Paired Mean	SD	T Value	p-value (Sig. 2-tailed)
1.	Right Relaxed	18.197	4.303	2.320	15.07	0.000
2.	Right Contraction	13.894				



Inference- The paired t-test shows that there is significant difference between knee relaxed and isometric contraction of right side in supine position i.e. $p<0.05$

Table 3: Left Q angle during quadriceps relaxed and during isometric contraction in supine

No.	Variables	Mean	Paired Mean	SD	T Value	p-value (Sig. 2-tailed)
1.	Left Relaxed	17.970	4.000	1.937	16.77	0.000
2.	Left Isometric	13.970				



Inference- The paired t-test shows that there is significant difference between knee relaxed and isometric contraction of left side in supine position i.e., $p<0.05$

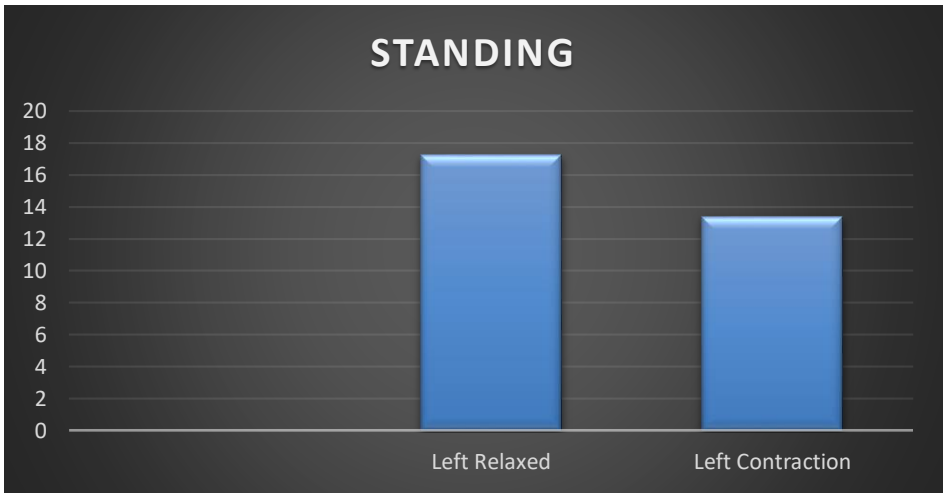
Table 4: Right Q angle during quadriceps relaxed and during isometric contraction in standing

No.	Variables	Mean	Paired Mean	SD	T Value	p-value (Sig. 2-tailed)
1.	Right Relaxed	17.636	3.788	1.926	15.98	0.000
2.	Right Isometric	13.848				

Inference- The paired t-test shows that there is significant difference between knee relaxed and isometric contraction of right side in standing position i.e. $p<0.05$

Table 5: Left Q angle during quadriceps relaxed and during isometric contraction in standing

No.	Variables	Mean	Paired Mean	SD	T Value	p-value (Sig. 2-tailed)
1.	Left Relaxed	17.258	3.848	1.850	16.90	0.000
2.	Left Isometric	13.409				



Inference- The paired t-test shows that there is significant difference between knee relaxed and isometric contraction of left side in standing position i.e. $p<0.05$

Table 6: Comparison of both side knee with quadriceps relaxed in standing and supine positions

	Q angle in supine	Q angle in standing	t value	p value
Rt relaxed	17.64±3.14	18.2±2.84	-1.08	0.284
Lt relaxed	17.26±2.80	17.97±2.80	-1.46	0.146

Inference- The table shows that there is no significant difference of Q angle value between supine and standing of both side knee relaxed, i.e. $p>0.05$

Table 7: Comparison of both side knee with isometric quadriceps contraction in standing and supine positions

	Q angle in supine	Q angle in standing	t value	p value
Rt contraction	13.85±1.76	13.89±1.87	-0.14	0.886
Lt contraction	13.41±1.57	13.97±1.38	-2.18	0.031

Inference- The table shows that there is no significant difference of Q angle value between supine and standing of both side knee with isometric contraction, i.e. $p>0.05$

DISCUSSION

The primary purpose of the study is to determine the changes in Q angle during isometric quadriceps contraction in females in supine and standing positions**.** The result obtained suggests that there is a significant difference in Q angle values between quadriceps relaxed and during isometric quadriceps contraction which supported the earlier findings.

Q angle is a clinical measurement used to measure knee alignment with respect to the hip, femur and tibia, and to evaluate the patella alignment. Though the three skeletal landmarks define the Q-angle, the location of the patella within the quadriceps tendon leads to alterations in the magnitude of the angle when the characteristics of the quadriceps musculature is affected (Livingston and Mandigo, 1997). The excessive lateral displacement of the patella with quadriceps muscle activation could be interpreted as a patellar tracking error, which has been believed to be the potential cause of patellofemoral pain. Patellofemoral pain is associated with patellar malalignment and quadriceps weakness which are seen more commonly in women.[(2)]

In this study, total 66 healthy young females of age group 18-25yrs had participated. These participants were evaluated as per the data collection sheet which included demographic data, and measurement of Q angle by goniometer. The Q angle was initially measured in supine with quadriceps relaxed in knee extension then during isometric quadriceps contraction and then in standing of both sides. It was found that there was a significant difference between quadriceps relaxed and during isometric quadriceps contraction on right ($p=0.000$) as well as left ($p=0.000$) side in supine as well as in standing positions. But there was no significant difference in Q angle values between supine and standing positions on either side.

The findings are supported by a research done by Bijish Kumar Bhaskaran, Rajan Balakrishnan, Edith Randy (2016) conducted a study on effects of isometric quadricep contraction on the Q angle among university female students in standing and supine position which was done on 30 female subjects with age group of 20-30 yrs. They concluded that there was a reduction in the value of Q angle during isometric quadriceps contraction and the magnitude of this decrease is corresponding to the magnitude of the Q angle before the isometric contraction, but there is no difference in the Q angle value in standing and supine. In the context of our study the results shows that the Q angle decreases with Isometric quadriceps contraction. But an excessive lateral displacement of patella during isometric quadriceps contraction, could be due to weak quadriceps muscle that increases the risk of patella tracking disorder which is also a cause of patellofemoral pain.[6]

Reduction in Q angle can be justified in studies analyzing the activation of vastus medialis oblique (VMO) and vastus lateralis (VL) muscles upon isometric exercises on the quadriceps having knee in total extension. Some factors such as the relative strength of the various components of-the quadriceps, the depth of intertrochlear groove, the shape of the patella, the presence of patella alta may explain why some individuals with high Q angles at rest show little difference when the quadriceps are isometrically contracted and other individuals with normal Q angles at rest show a considerable decrease.[2]

High Q angle affects the biomechanics of knee joint especially patellofemoral articulation by creating an abnormally high valgus angle. This exerts a laterally directed force leading to maltracking and excessive pressure on the patellofemoral articulation and shifts the patella laterally and rotates it medially, thus increasing patellofemoral contact pressure, which consequently result in anterior knee pain. Emami et al observed the fact that patients with anterior knee pain have larger Q angles than healthy individuals.[6] H.H. Huberti also proved that tendofemoral contact of Q angle at higher angles of flexion carries the significant fraction of the total contact force, reducing the load on the patella.[2]

In our study it was found that there was no significant difference in Q angle values in supine and standing positions with quadriceps relaxed with p=0.284 and p=0.146 or during isometric contraction with p=0.886 and p=0.031 on right and on left respectively.

The results are supported by research done by Anuj Kumari et al on effect of isometric quadriceps contraction on the Q angle in standing and supine positions among young females on 50 female participants with age 18-30 years. The conclusion was that there was Q angle decrement with static quadriceps contraction in both standing and supine positions but there was no significant bilateral variability. Many studies have shown that an increase in Q-angle values was found when a transfer is made from lying to a erect posture and higher Q-angle upon erect position is due to transfer of weight in lower limb from body.

Aprajita Raizada et al conducted a study on changes in quadriceps angle (q-angle) with regard to gender and different anthropometric parameters, on 148 young healthy males and females (age 18-20 yrs) shows that there is no significant difference in Q angle between both the genders. This concludes that Q angle has variability in gender because of anthropometric measure like height and pelvic width (small difference of 2 to 3 degree). Many study results have reported that exaggerated Q angle is associated with increased pelvic width to length of femur ratio. Also small height persons have larger Q angle as compared to larger height persons so females have higher Q angle as compared to males.[2]

As we know high Q angle potentiates the malalignment or maltracking of the patella which may lead to patellofemoral disorder. In patellofemoral disorder rehabilitation, SLR or Straight leg raised is a way of treatment to strengthen the knee. Based on this study, we believe that if it associated to the quadriceps exercises, it can minimize the excess value of Q angle. Aparna Sarkar et al emphasize the strengthening of the hip abductor muscle due to kinematical imbalance of lower limbs. It is also wise to initiate a kinesiotherapeutic SLR exercising program associated to the hip abduction. Physical exercises promote a sensorial reeducation through the motor activity and this is beneficial to patellofemoral disorder bearer individuals since in general they present proprioceptive abnormalities.

CONCLUSION

The study concludes that there was a significant difference between Q angle values in quadriceps relax and during isometric quadriceps contraction on right as well as left side thus accepting the alternate hypothesis. Also, it was found that there was no significant difference between the Q angle values in standing and supine position that supports the previous studies.

LIMITATIONS

- The study is only done in females.
- Study is only done in asymptomatic subjects.

SUGGESTIONS

- The Q angle can be correlated with parameters like height, weight, BMI, pelvic width, femur length, hip abductor strength
- Study can be done on large samples.
- Symptomatic subjects and those having knee pathologies can be taken into the study.
- Radiographic imaging can also be used to measure Q angle.

CLINICAL IMPLICATIONS

Those having higher Q angle values can implement quadriceps strengthening exercises in their routine like SLR or straight leg raise. Strengthening of the hip abductor muscle can also be done.

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