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EFFECT OF ISOMETRIC QUADRICEP ACTIVATION ON "Q" ANGLE IN YOUNG FEMALES

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Abstract : The Q angle represents an estimate of the resultant force of the quadriceps on the patella and is a predictor of the lateral movement of the patella under dynamic conditions. The aim of the present study was to observe whether Isometric Quadriceps Activation (IQA) can decrease the Q angle and to identify people at high risk of patellar subluxation. Q angles were measured in 23 non impaired young women (22.9±2.3 years) in relaxed standing and during IQA. There was a significant decrease (4.65±2.74°) in the Q angle values for subjects with IQA as compared to subjects with measurements in relaxed standing Significance levels were set at $P<0.05$. The Q angle decreases with IQA which was highly significant ($t=8.01$, $P<0.001$). The result supports the view that an excessive Q angle may predispose women to greater lateral displacement of the patella during vigorous activities and sports in which the quadriceps muscle is stressed.

Key words : Q angle quadriceps femoris muscle isometric quadriceps activation goniometer patella

INTRODUCTION

Quadricep (Q) angle is formed by the resultant force of the quadriceps femoris muscle on the base of the patella and the line of the patellar ligament on the apex of patella (1). 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 patella is embedded in the tendon of quadriceps femoris complex, therefore the magnitude of Q angle varies with changes with strength and tonus of musculature. 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 (3, 4). A common clinical estimate of this resultant force vector is made by a line connecting anterior superior iliac spine to mid point of patella, this vector is then related to the alignment if patellar ligament from midpoint of patella to tibial tubercle (5, 6).

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Emami et al substantiated the fact that patients with patellofemoral pain are associated with patellar malalignment and quadriceps weakness which are seen more commonly in women (7). H.H. Huberti 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. Both increase and decrease in Q angle lead to more non uniform pressure distribution with higher peak stresses and unloading of other areas (8). The aim of the present study was that whether IQA can decrease Q-angle since higher Q-angle potentiates patellofemoral pain which in turn leads to patellar subluxation. Clinically we can implement this study in subjects with high risk of patellar instabilities by introducing isometric quadriceps activation as a part of rehabilitation protocol.

MATERIALS AND METHODS

Subjects

Subjects (n=23) in this study were non impaired, pain free women of age group 20–30 years (22.9±2.3 years). Only women were recruited for this study, because they have larger Q angles and a higher incidence of patellofemoral problems. Exclusion criteria consisted of prior history of knee pathological conditions, complaint of knee pain, traumatic/surgical records or any pathology involving any of the joints of the lower limbs, vascular, peripheral or central neurological disorders.

Procedure

Before performing the assessments, all volunteers were clarified on the procedure used in the research. All participants read and signed the consent form. Data collection required one testing session lasting 20–30 minutes per subject. Small markers were applied to the right Anterior Superior Iliac Spine (ASIS), midpoint of right patella and the middle of the right tibial tubercle for measurement of the Q angle. The midpoint of patella was determined by the intersection of the line from the medial to lateral patella and a line from the inferior to superior patella. Since the skin moved relative to the patella during IQA, use of a single mark for both conditions would have produced a considerable error in measurement. To account for the movement of the patella relative to the skin, the midpoint of patella was first marked with the quadriceps relaxed and then with the quadriceps contracted, thus, making 2 marks. The midpoint of patella was rechecked between test conditions.

Bilateral goniometric measurements of the Q angles were taken with subjects in the standing position with knees extended and their feet shoulder width apart and parallel to each other with their weight evenly distributed over both feet using a standard goniometer modified with an extension rod attached to the stationary arm to ensure accurate alignment with ASIS. For the IQA condition, subjects were simply told to produce a strong quadriceps contraction and hold it for 5 seconds. Standing position was chosen for 2 reasons. First, recent studies suggest no clinically significant difference in standing and supine positions. Second, standing with weight bearing through lower extremity represented a more functional position to measure the Q, angle.

Standing Q angle reflects a composite measure of pelvic angle, hip rotation, tibial rotation, patellar position and foot position.

The degrees of pronation and supination of the foot, hip anteversion and retroversion and hip internal and external rotation have been found to affect the Q angle. Although the degree of pronation and supination was not controlled and the presence of hip anteversion and retroversion was not determined in the study, the subjects initial relaxed standing position was recorded by marking the foot positions on the floor. The same position was then used throughout testing to ensure the same foot and leg position. If the subjects Q angle was influenced by these factors, it was assumed the influence was similar on all measurements taken in standing.

Statistical analysis

To assess the mean difference in the Q angle between pre-IQA and during IQA paired t-test was applied. The level of significance was set at $P<0.05$.

RESULTS

Fig. 1 showed the Q-angle comparison between pre IQA and during IQA. The mean value for Q angle before IQA came out to be 16.2±3.49 and during IQA it was 11.6±1.69. The difference of mean between pre and during IQA was 4. 65±2.74. t-test was applied ($t=8.01$, $P<0.001$). The result was statistically significant.

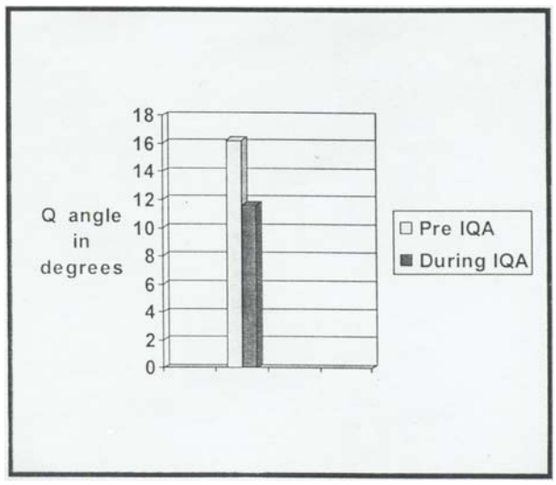

Fig. 1: Comparison of Q angle (in degree) between pre IQA and during IQA.

DISCUSSION

The results of this study presented in Fig. 1 which supported the earlier findings that the Q angle decreases with IQA. Excessive lateral displacement of the patella with quadriceps muscle activation could be interpreted as a patellar tracking error, which has been hypothesized as being a potential cause of patellofemoral pain. Patellofemoral pain is associated with patellar malalignment and quadriceps weakness which are seen more commonly in women (9).

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. 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 activated and other individuals with normal Q angles at rest show a considerable decrease.

High Q angle influences biomechanics of knee joint and 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 (7). H.H. Huberti 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 (8).

Theoretically, a higher Q angle increases lateral pull of quadriceps femoris muscle on patella and potentiates patellofemoral disorders (7, 10–11). The SLR, an exercise performed having the leg straight raised, is a way of treatment much employed in the patellofemoral disorder rehabilitation. Present treatment protocols emphasize the strengthening of the abductor muscles of hip due to kinematical imbalance of lower limbs. It is also wise to initiate a kinesotherapeutic SLR exercising program associated to the hip abduction (12).

It can be concluded from the present study that there was a reduction in the value of Q angle and the magnitude of this decrease is relative to the magnitude of the Q angle before the isometric activation. Measuring the change in the Q angle with IQA compared with the resting Q angle may enhance a clinician's ability to predict which individual is at greater risk of developing patellar tracking and patellar dysfunction.

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