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Effect of Body Position on Measurement of Q Angle in Trained Individuals with and without Patellofemoral Pain

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ABSTRACT

Purpose: To explore the difference between measuring the Q-angle from standing and supine position in trained subjects suffering from patellofemoral pain.

Methods: The patellofemoral pain group (study group) consisted of 30 male participants (age = 26.8 ± 4.5 years, height = 172.9 ± 7.2 cm, mass = 73.3 ± 16.7 kg), the control group consisted of 30 male participants (age = 25.6 ± 2.8 years, height = 170.7 ± 8.4 cm, mass = 71.5 ± 15.9 kg) who were matched on age, height, and mass to the patellofemoral pain volunteers. The Q angle was measured from standing and supine position.

Results: There was a significant difference between study group and control group at standing (p = 0.000) and supine position (p = 0.002). There was no effect of body position; either standing or supine on the values of Q angle for control group (p = 0.062). However, the Q angle value of study group in standing was significantly higher than its value in supine lying position (p = 0.000).

Conclusions: Q angle measured from standing position is higher than that measured from supine lying for subjects suffering from patellofemoral pain. Therefore; it is recommended to perform Q angle measurements in the standing position for subjects suffering from patellofemoral pain.

Key words: Q angle, standing, supine lying, Patellofemoral pain

Introduction

The quadriceps or Q angle was initially described by Brattström [1]. It is an index of the vector for the combined pull of the extensor mechanisms and the patellar tendon [2,3,4]. It is measured by drawing a line from the anterosuperior iliac spine to the centre of the patella, and a second line from the center of the tibial tubercle to the center of the patella. The angle where these lines intersect is regarded as the Q angle [5,4]. Traditionally, the Q angle has been measured with subjects in supine, knee extended and with the quadriceps muscle relaxed [6]. This is regarded as the 'traditional' or 'conventional' method of assessing Q angle. The Q angle has also been assessed on standing [7, 8].

The Q angle measurement is widely used as an indicator of patellofemoral dysfunction, including patellofemoral pain syndrome (PFPS) and patellar instability [7, 9, 10]. An exaggerated Q angle can lead to greater pull at lateral direction [11, 12] which in turn increases the retropatellar pressure [13-15]. The resultant will be an increase in pressure between the lateral trochlear ridge and the patella which might causes pain and be the source of PFPS, and ultimately leads to degeneration of the articular cartilage [3, 4, 8, 14, 16, 17]. In addition, this increase in contact pressure may increase the likelihood of lateral patellar subluxation or dislocation [18]. It has also been suggested that an abnormal Q angle may also influence neuromuscular response and quadriceps reflex response time which are considered as an etiological factors in PFPS [19].

A number of studies have; however, reported no relationship between Q angle and patellofemoral joint symptoms [2, 20-22]. Accordingly, measurement of the Q angle has been reduced in popularity among clinicians, as it does not add to patient

management [5, 23]. Although Insall et al.'s [6] method of Q angle measurement remains popular; its reliability has not been established.[5]. Therefore, the purpose of this study was to explore the difference between measuring the Q angle from standing and supine position in subjects suffering from patellofemoral pain.

Materials and Methods

Subjects

Sixty right hand dominant trained volunteers (30 with patellofemoral pain, 30 controls; without patellofemoral pain) between the ages of 18 and 40 years participated in the study. The patellofemoral pain group (study group) consisted of 30 male participants (age = 26.8 ± 4.5 years, height = 172.9 ± 7.2 cm, mass = 73.3 ± 16.7 kg). Inclusion criteria for the patellofemoral pain group included 1) anterior or retropatellar right knee pain (unilateral knee pain) presents during at least 2 of the following activities: ascending or descending stairs, hopping or running, squatting, kneeling, and prolonged sitting; 2) insidious onset of symptoms not related to trauma; 3) pain on palpation of the patellar facets; and 4) worst pain in the past week greater than or equal to 3 cm on a 10-cm visual analog scale. Inclusion criteria were adapted from Cowan *et al*. [24].

The control group consisted of 30 males (age = 25.6 ± 2.8 years, height = 170.7 ± 8.4 cm, mass = 71.5 ± 15.9 kg) who were matched on age, height, and mass to the patellofemoral pain volunteers. Subjects considered trained if they were engaged in an aerobic activity at least three times weekly for more than 20 minutes a session [25]. Exclusion criteria for the patellofemoral pain and control groups included 1) history of knee surgery, 2) clinical evidence of other knee injury, or 3) current significant injury affecting other lower extremity joints. Before data collection, all participants signed an informed consent. Additionally, all volunteers completed a 10-cm visual analog scale (VAS) for ''worst knee pain during the previous week".

Procedures

The Q angle was measured for both groups from two position standing and supine position at the same session. Standing Q angle: Measured in the frontal plane using a standard goniometer modified with an extension rod attached to the stationary arm to insure accurate alignment with the anterior superior iliac spine. The inferior prominence of the anterior superior iliac spine was palpated, and the subject's finger was carefully and firmly placed over the prominence. The boundaries of the patella and tibial tuberosity were palpated, and the center positions were marked. With the goniometer axis over the patella center, the angle formed by a line from the anterior superior iliac spine to the patella center and a line from the patella center to the tibia tuberosity was measured [26].

Supine Q angle: The subjects were supine, their quadriceps relaxed and their knees flexed 10°. The hip and leg were maintained in neutral rotation with the patella pointing upwards, the longitudinal axis of the foot is vertical to the horizontal line. The Q angle was measured by using a standard goniometer and applying the same procedure [8]. Q angle of control group was measured on the right leg of each subject.

Data Analysis

Data was analyzed using the Statistical Package for Social Sciences (SPSS) for windows version 16.0. (SPSS, Inc., Chicago, Illinois). Paired *t*-test used to examine the effect of body position on Q angle within groups and independent *t*-test used to compare between the study and control group. Level of significance for all tests was set at 0.05 for all statistical tests.

Results

Descriptive statistics for Q angle of study group and control group from standing and supine position are reported in table 1. The independent t-test showed a significant difference between the study group and the control group at standing position ($p = 0.000$) and supine position ($p = 0.002$). There was no effect of body position (standing and supine) on the values of Q angle for the control group ($p = 0.062$). However, the Q angle value of study group in standing was significantly higher than its value in supine lying position ($p = 0.000$).

Groups	Study group	Control group
Standing Q angle	17.95 ± 4.53	11.87 ± 4.02
Supine Q angle	14.60 ± 3.98	11.45 ± 3.66

Discussion

This study was conducted to examine the effect of body position on the Q angles values in subjects suffering from anterior knee pain. The results revealed that no effect of body position (standing and supine) on the value of Q angle in healthy group. In contrast, the anterior knee pain group recorded higher Q angle from standing than supine lying. These results can be explained according to the findings of Guerra *et al*. [8] who reported that although the significant increase in pelvic width in standing when compared with supine may appear to compensate for the lateral movement of the patella, the differences were small in normal healthy subjects. The

reason of the increased distance between the ASISs in standing has not been investigated, but possible causes include increased lateral forces on the ilia from the increased weight of the abdominal organs or biomechanical changes in the sacroiliac joints.

Several other factors that could influence the Q angle measurement in standing include the position of the foot [27], pes planus, foot pronation, and surrounding soft tissue abnormalities [28]. These factors should not influence the Q angle in the supine position. The measurement procedure of current study attempted to decrease the influence of foot, ankle, leg, and thigh positions between standing and supine by controlling the positions of the foot and rotation of the hip in both positions.

Livingston and Mandigo [26] investigated the between-group (male versus female) and within-subject (right versus left lower limb) differences in Q angle measures in a group of subjects with no history of knee disorders. Results showed that the left Q angle was greater in magnitude than the right Q angle which explain why only the right knee Q angle was measured for study and control group to avoid difference between body sides. Moreover, the study was conducted only on males to avoid gender difference as many authors [8, 29, 30] reported greater Q angle in female than in males, due to lateralized position of anterior superior iliac spine [31]. Moreover, Q angle has been believed to vary between males and females; however the slight difference of only 2.3 degrees appears to be related to height rather than pelvic dimensions. Shorter statured individuals appear to have larger Q angles and therefore the slight difference between genders may be attributed to men being taller than women [31].

Normative Q angle values has been reported in the literature. It ranges from 8° to 15° in males and 12° to 19° in females [8, 26, 29, 30, 32]. When these gender differences are considered, angles greater than 15° for men and greater than 20° for women have been suggested as clinically abnormal [33, 34]. Our values would appear to be somewhat consistent with these outer limits.

Huberti and Hayes [35] used cadaver knees and a special loading fixture found that the increase and the decrease Q angle has increased peak patellofemoral pressures. These increased pressures may predispose an individual to degenerative pathological changes [35]. Increasing the Q angle is associated with increased lateral patellofemoral contact pressures and patellar dislocation, while decreasing the Q angle may not shift the patella medially, but rather increases the medial tibiofemoral contact pressure through increasing the varus orientation of the knee [14]. The effect of Q angle has been examined in a number of studies [7, 36-41]. Three studies reported the Q angle to be significantly increased in patellofemoral pain syndrome subjects against controls [38-40], while four studies reported no difference in Q angle [7,36,37,41].

In agreement with the results of the current study, Biedert and Warnke [42] suggested that high and low Q-angles should be considered abnormal and an aetiological factor of patellofemoral disorders, where high values indicate PFPS, and low values suggest patellar instability. Therefore, this study established a standardized clinical Q angle assessment protocol for patellofemoral pain conditions. The results of this study will enable clinicians to use the Q angle as a suitable clinical measure to assess patellofemoral pain syndrome and patellar instability patients.

This study was limited by the following: The first limitation of this study is the decreased ability to determine a cause-and-effect relationship within case-control design. We cannot determine if the increase in Q angle was present before or after the patellofemoral pain developed. Future authors should use a prospective cohort design to determine if increasing Q angle value is a risk factor for patellofemoral pain. Secondly, the gender in this study was limited to males only. Thus, the appropriateness of generalizing the results is confined to this specific population. Lastly, this study was limited to a relatively young sample. Therefore, the results of the present study will be more generalizable to similar age group.

Conclusion

Based on the findings of the current study, it is recommended to perform Q angle measurements in the standing position for trained subjects suffering from patellofemoral pain. The standing position represents the functional position of the lower limb more appropriately than the supine position.

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