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Comparison of the Torso Stabilizer Muscles Endurance in Female Athletes with and Without Patellofemoral Pain Syndrome

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Abstract: The purpose of this study was to compare the torso stabilizer muscles endurance in female athletes with and without patellofemoral pain syndrome. Diminished hip strength has been implicated as being contributory to lower-extremity misalignment and patellofemoral pain but other proximal muscle groups including the torso stabilizer muscles has not been investigated. Thirty female athletes diagnosed with patellofemoral pain syndrome (mean age; 21.60±2.75, mean weight; 60.70±8.70 and mean height; 165±.073) and 30 asymptomatic females athletes (mean age; 20.77±2.63, mean weight; 60.53±6.66 and mean height 164±.063) with history of 3 years participating in volleyball, basketball or handball for all subject, participated in this study. The protocol established by McGill was used to determine muscle endurance of the torso stabilizer muscles. The protocol consists of four tests that measure all aspects of the torso via isometric muscle endurance: trunk flexor test, trunk extensor test (Beiring Sorensen test) and left and right lateral musculature test (Side bridge test). Data were analyzed using the independent samples t-test in SPSS program and with the significance level set at $P<0.05$.The results showed a statistically significant difference between the two groups for torso stabilizer muscles endurance ($P=.001$) and the greatest differences were found in anterior part of the torso muscle endurance (abdominal muscles). The results indicate that young women with patellofemoral pain are less likely to demonstrate endurance in torso stabilizer muscles than age-matched control group women who are not symptomatic. In conclusion, based on this study results, it's proposed that the torso stabilizer muscles endurance training would be used for prevention and treatment of Patellofemoral pain syndrome in persons with similar characteristics of this study samples.

Key words: Patellofemoral Pain Syndrome % Female Athletes % Torso Stability % Endurance Muscles

INTRODUCTION

Patellofemoral pain syndrome is anterior knee pain; the pain is generated by retinaculum, subchondral bone, synovium, or local small nerve endings and muscle [1]. Several factors include overuse and overload of the patellofemoral joint, biomechanical problems, muscular dysfunction and acute injury contribute to patellofemoral pain. Patellofemoral pain syndrome (PFPS) is most common in athletes with reported incidence rates greater than 25 % [2]. It has also been reported that females, as compared with their male counterparts, are significantly more likely to experience PFPS Females are at greater risk of developing PFPS because of anatomical differences that result in higher Q angles as compared to males [3].

Core stability is the product of motor control and muscular capacity of the lumbo-pelvic-hip complex [4] proposing that the stability of the pelvis and trunk is necessary for all movements of the extremities. The influence of foot mechanics on proximal structures has been studied extensively. However, the influence of proximal stability on lower extremity structure and pathology remains largely unknown. There is a clear relationship between trunk muscle activity and lower extremity movement. Current evidence suggests that decreased core stability may predispose to injury and that appropriate training may reduce injury. Researchers identified trunk muscle activity before the activity of the lower extremities, which served to stiffen the spine to provide a foundation for functional movements [1, 2].

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Considering the wide variety of movements associated with athletics, athletes must possess sufficient strength in hip and trunk muscles that provide stability in all three planes of motion. They also found that the transvers abdominus is the first muscle to become active prior to actual limb movement. Researchers found that antagonistic trunk muscle co activation is necessary to maintain the lumbar spine in a mechanically stable equilibrium [5]. The abdominal muscles control external forces that may cause the spine to extend, laterally flex, or rotate the abdominals have also been reported to increase the stability of the spine through co-contraction with the lumbar extensors [6]. Due to its architectural features and location, the quadratus lumborum is also reported to be a major stabilizer of the lumbar spine. In addition to production of lateral trunk flexion; this important muscle has been shown to be active for most tasks that require lumbar flexion and extension moment development. Ireland *et al.* [5] further suggested that the abdominals also control excessive anterior pelvic tilt, which is believed to be coupled with femoral internal rotation and adduction. Hip abductors and external rotators also play an important role in lower extremity alignment hip adduction and internal rotation, leading to knee valgus and tibial external rotation [7]. The same alignment tendency has also been linked to repetitive injuries such as patellofemoral pain syndrome. Also Relationship between hip abductors and external rotators weakness with patellofemoral pain syndrome is significant. Based on the results of studies, core stability has an important role in injury prevention. Therefore, a need for proximal stability in order for lower extremity injury prevention is necessary [8]. The hip musculature theoretically plays a significant role within the kinetic chain with activation of the hip extensors, flexors and abductors required for all ambulatory activities, stabilization of the trunk/pelvis and in transferring force from the lower extremities to the pelvis and spine [9-11].

Researchers suggested that the knee may be a “victim of core instability” with respect to lower extremity stability and alignment during athletic movements. Stability and movement are critically dependent on the coordination of all these hip and trunk muscles. Diminished hip strength has been implicated as being contributory to lower-extremity misalignment and patellofemoral pain but other proximal muscle groups including the torso stabilizer muscles has not been investigated. The purpose of this study was to compare the torso stabilizer muscles endurance in female athletes with and without patellofemoral pain syndrome.

MATERIALS AND METHODS

Subjects: Thirty female athletes diagnosed with patellofemoral pain syndrome (mean age; 21.60±2.75 years, weight; 60.70±8.70 kg and mean height; 165±.073 Cm) and 30 asymptomatic females athletes (mean age; 20.77±2.63 years, mean weight; 60.53±6.66 kg and mean height; 164±.063 Cm) with history of 3 years participating in volleyball, basketball or handball for all subjects participated in this study.

Females athletes in the experimental group participated in this study if they complained of 1) positive clark’s test, 2) pain for a minimum of 3 month and 3) anterior knee pain during at least 2 of the following provocative activities: (a)stair ascent, (b) squatting, (c) kneeling, or (d) prolonged sitting. In these individuals, the most affected lower extremity was tested. Potential subjects from either group who reported a history of pregnancy, low back pain, joint laxity, lower extremity misalignment, patellar dislocation, patella instability, knee surgery, hip surgery or other significant trauma either lower extremity [1] were excluded from the study. Inclusion criteria for the PFPS group were satisfied through a thorough evaluation at a local orthopedic practice.

Thirty Control subjects participated in the study if they had no pain with any of the above-named provocative activities.

Procedure: The protocol established by McGill [2]. was used to determine muscle endurance of the torso stabilizer muscles. The protocol consists of four tests that measure all aspects of the torso via isometric muscle endurance: trunk flexor test, ICC (3, 1) = .98, trunk extensor test (modified Biering-Sorensen test) [2], ICC (3, 1) = .93 and left and right lateral musculature test (side bridge test), ICC (3, 1) = .95(45). Subjects were allowed to practice each position. To prevent fatigue, they were not allowed to hold any one position for more than five seconds. Individuals were given a minimum of five minutes rest between each test. In relation to movement, all aspects of the torso stabilizer muscles work as a single unit. Thus each of the individual torso stabilizer muscles endurance tests was totaled to produce a single “total” value. Endurance of the posterior torso stabilizer muscles was measured using the modified Biering-Sorensen test (trunk extensor test) [2].

Athletes performed the flexor trunk test as described by McGill *et al*. [15].

Athletes performed the side bridge test as described by McGill *et al*. [15] as a measure of lateral torso stabilizer muscles, particularly the quadratus lumborum.

Data Analysis: Data were analyzed using the independent samples t-test. Statistical significance was set at P = 0.05. SPSS 13.0 software was used for all analyses.

RESULTS

Descriptive statistics were performed on all data. After determining normal distribution of the test variables, the independent samples t-test were used to identify comparison of torso stabilizer muscles endurance between female athletes with and without patellofemoral pain syndrome.

Data analysis of this study revealed significant difference between the posterior torso stabilizer muscles endurance, anterior torso stabilizer muscles endurance, left torso stabilizer muscles endurance and total torso stabilizer muscles endurance in female athletes with and without patellofemoral pain syndrome. But no significant differences between the right torso stabilizer muscles endurance in female athletes with and without patellofemoral pain were detected.

Mean torso stabilizer muscles endurance (posterior, anterior, right, left and total) variables, P value and T were listed in Table 1 and comparison of mean torso stabilizer muscles endurance (total) between PFPS Group and Control Group was demonstrated in Figure 1.

DISCUSSION

The purpose of this investigation was to compare torso stabilizer muscles endurance between females with and without PFP. While mean torso stabilizer muscles endurance for the healthy control subjects in this study were higher than PFPS group. Female athletes with PFPS demonstrated significant weakness.

Mascal *et al.* [4] suggested that a hip, pelvis and trunk muscle strengthening program positively affects lower extremity kinematics during stair-stepping in a subject diagnosed with PFPS. They concluded that a decrease in both hip adduction and internal rotation would move the patella lateral relative to the ASIS and decrease the dynamic Q angle. Leetun and Ireland [1] noted that females have less hip extension strength and greater trunk extension endurance, while males have greater quadratus lumborum endurance and isometric hip abduction as well as greater hip external rotation torque. It was concluded that females have a lower stable foundation upon which to develop or resist force in the lower extremity [15]. Mannion [16] stated that there is an alteration in firing of the proximal hip musculature in people with anterior cruciate ligament insufficiency. Zazulak *et al*. [11] stated that deficits in neuromuscular control of the trunk are predicted for knee injury risk.

Ireland *et al.* [5] showed that PFPS subjects demonstrate 26% less hip abductor strength and 36% less hip external rotation strength compared to controls. They have reported significant hip weakness in subjects diagnosed with PFPS. However, unlike Ireland *et al.* [5], Piva *et al.* [8] did not report significant hip external rotator weakness. A possible reason for this finding was the procedure. Relationship between hip strength and frontal plane posture of the knee during a forward lunge is significantly Giussan [2] and Akuthota and Nadler [3], proximal muscle weakness leading to lower extremity injury [17, 18].

Sato *et al*. have reported not significant effect Core Strength Training on Lower-Extremity Stability. Despite the fact significant correlations were not identified between core strength and athletic performance. At the same time, the core is no more important than any other body part. Weak trunk muscles, weak abdominals and imbalances between trunk muscles groups are not a pathology just a normal variation, Weak or dysfunctional abdominal muscles will not lead to back pain, also Core

Table 1: Torso stabilizer muscles endurance comparison between female subjects with patellofemoral pain syndrome (PFPS) and the control group (n=30)

Variable	PFPS Group	Control Group	T	P-value
Posterior torso stabilizer muscles endurance	70.77± 33.34	87.37±29.06	2.056	0.004
Anterior torso stabilizer muscles endurance	72.23± 46.43	118.57± 58.15	3.410	0.001
Right torso stabilizer muscles endurance	38.07±21.35	46.13±20.77	1.483	0.143
Left torso stabilizer muscles endurance	34.93±17.64	45.97± 22.33	2.123	0.038
total	216.00± 85.51	298.03± 89.99	3.619	0.001

All values are expressed as a (mean ± SD). n =30. Significance was set at P = 0.05

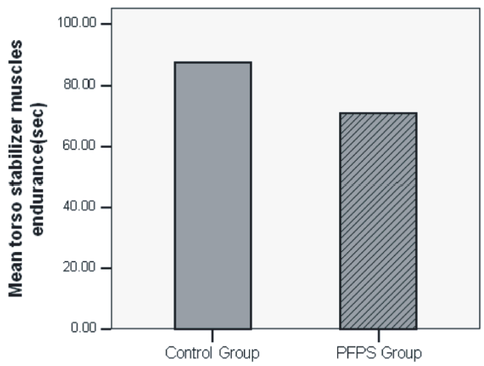

Fig. 1: Comparison of total torso stabilizer muscles endurance between female athletes with patellofemoral pain syndrome (PFPS) and the control group

stability exercises are no more effective than and will not prevent injury more than, any other forms of exercise. Stated Core stability exercises are no more effective than and will not prevent chronic low back pain more than, any other forms of exercise. Suggests that the abdominals also control excessive anterior pelvic tilt, which is believed to be coupled with femoral internal rotation and adduction.

The muscles of the lumbar spine are enclosed in the thoracolumbar fascia. The thoracolumbar fascia consists of three layers: the anterior, middle and posterior layers. The anterior layer encases the psoas major and quadratus lumborum muscles. The middle layer arises from the tips of the transverse processes of the lumbar vertebrae and intervenes between the erector spinae and the quadratus lumborum, where it is continuous with the inter-transverse ligaments. The posterior layer covers the erector spinae and its aponeurosis. Of these three layers the posterior layer has the most important role in supporting the lumbar spine musculature. Lumbar Spine attach to biceps femoris and gluteus maximus by thoracolumbar fascia and sacrotuberous ligament attachments [19]. The primary hip extensors include the gluteus maximus and hamstrings, which include the semitendinosus to the spinal column, include the erector spinae, quadratus lumborum and multifidus.

Abdominal and torso stabilizer weakness leading to decrease strength of hamstrings and quadriceps muscles However, hamstrings and quadriceps muscles weakness can cause PFPS. The gluteus medius (GM) originates from the iliac crest and inserts onto the lateral surface of the greater trochanter. Although the GM is commonly known as a strong hip abductor, it is functionally more important as a hip stabilizer. If gluteus medius is not working correctly, the body must compensate with contributions from other muscles such as the quadratuslumborum also, lateral torso stabilizer muscles weakness leading to GM weakness. However, GM weakness can cause an increase in: 1) hip adduction, 2) knee valgus and 3) lateral patella compressive forces. Weakness of GM increase frontal and transverse plane stress to patellofemoral joint and tibial femoral joint increase pelvic tilt [20].

The hip musculature thus plays a significant role in transferring forces from the lower extremity up towards the spine during upright activities. Poor endurance and delayed firing of the hip extensor (gluteus maximus) and abductor (gluteus medius) muscles have previously been noted in individuals with lower extremity instability. The Hip weakness leading to Abnormal movements in femoral and tibial and affect patellofemoral contact pressures .The hip external rotators and hip abductor also play an intricate role for hip stabilization. Hip adduction and internal rotation, leading to knee valgus and tibial external rotation. Knee valgus represents a frontal plane motion that may result from femoral adduction, because the hip abductors provide frontal plane stabilization, weakness can lead to excessive hip adduction and increased knee valgus together and these motions can increase the Q angle and adversely affect patellofemoral joint function. A higher Q angle (knee valgus) shifted the patella laterally and increased lateral patellofemoral joint contact pressures interestingly; the same alignment tendency has also been linked to repetitive injuries such as patellofemoral pain syndrome. The role of trunk stabilizers is to retain the musculature; to control, coordinate and optimize function; especially that of the spine when the field hockey player is hitting the ball, tackling or dribbling. Trunk fatigue, which occurs during intense training or matches, produces a loss in synchrony between upper and lower extremities, which may cause a reduction in muscle strength.

A limitation of the cross-sectional nature of this study lies in our ability to discern cause and effect. Symptomatic individuals in our study had at least a 3-month history of PFP. Therefore, the strength differences observed in this study may be the consequence of disuse atrophy or altered motor recruitment patterns.

CONCLUSION

The results of our investigation indicate that females presenting with PFP demonstrate significant hip abduction and external rotation weakness compared to age-matched, non- symptomatic controls.

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