World Journal of Sport Sciences 3 (1): 07-10, 2010
ISSN 2078-4724

The Effect of Open and Closed Kinetic Chain Exercises on Patellofemoral Syndrome Patients

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Abstract: The purpose of this study was to verify the efficiency of closed kinetic chain exercise and open kinetic chain exercise protocols on patellofemoral syndrome (PFS) rehabilitation. Thirty four female patients with patellofemoral syndrome (PFS) were randomly divided into two groups named G1 and G2. The first group received only closed kinetic chain exercise (CKC) while the second group received only open kinetic chain exercise (OKC) with a program of eight weeks twice a week. Some parameters such as Pain, Quadriceps angle (Q-angle) and knee proprioception were measured for lower limbs. We used paired t-test to evaluate the effects of performing exercise program in each group. Independent t-test was also employed to compare two groups for performing different exercises protocols. After treatment, results showed a significant decrease in both groups in the terms of pain and Q-angle. However both groups showed unchanged results in the impairment of knee joint position sense. These data suggest that treatments based on exercises for quadriceps femoris strengthening produced improvements on a number of PFS signals and symptoms, with no evidences of differences between OKC and CKC exercises.

Key words: Q-angle % Patellofemoral syndrome % Anterior knee pain % Knee proprioception % Chain exercise

INTRODUCTION

Patellofemoral syndrome is one of the most common joint complaints [1]. The Patellofemoral syndrome is characterized by prior retropatellar pain [2] and affects athletes and non-athletes, representing a common knee problem for physically active teenagers and young adults [3]. Although it has not been clearly established it's etiology may be correlated to several factors leading to patellar misalignment, such as an increased Q-angle, high or low patella position, excessive subtalar pronation, tibial lateral rotation femoral anteversion, valgus or varus knees and lateral retinaculum, Ischiotibial and iliotibial tract muscle's shortening [4, 5].

Patients with patellofemoral syndrome (PFS) present with anterior or retropatellar diffuse pain that is exacerbated by activities such as climbing up and down stairs, remaining at sitting position for long periods of time, squatting or kneeling, in which there are increased compressive forces on patellofemoral joint.

The Q-angle represents the resultant force of the quadriceps femoris muscle group on the patella relative to the alignment of the patellar ligament [6]. A common clinical estimate of this resultant force vector is made by a line connecting the anterior superior iliac spine (ASIS) to the midpoint of the patella , this vector is then related to the alignment of the patellar ligament from the midpoint of the patella to the tibia tubercle [7- 9].

The Q-angle creates a lateral force vector on the patella and predisposes the patella to lateral displacement during activation of the quadriceps [8]. The magnitude of this lateral force vector and the tendency for lateral displacement of the patella are believed to increase as the Q-angle increases [10, 6]. Women have consistently been found to have larger Q-angles than men [10, 9] and are more often affected by patellofemoral problems [11]. This is possibly due to an increased pelvic width [12] shorter femur length, or femoral neck ante -version [13]. Normal values of the Q-angle have been shown to vary between 10 and 14 degrees for men and 14 and 17 for women [2, 11, 9]. An increase in the Q-angle may also cause an increase in the pressure between the patella and the underlying lateral femoral condoyle during activation of the quadriceps [14].

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Proprioception is a sense of position and movement of one's own limbs and body in the absence of Vision termed "limb-position sense" and "kinesthesia", respectively Proprioception has been shown to diminish with injury, age and so on. It seems that PFS can also diminish knee joint proprioception. The purposes of this study were three fold. First: to confirm that a change occurs in the Q-angle with open and closed kinetic chain exercise. Second: to determine whether open and close kinetic chain exercises can decrease the impairment of knee joint position sense or not. Third: to determine if (OKC) and (CKC) can decrease the pain in patellofemoral syndrome patients.

MATERIALS AND METHODS

Subjects: The population studied consisted of 34 female patients with diagnosis of PFS who performed open or closed kinetic chain exercise in two groups. Patients were included if aged between 20 and 35, did not practice physical activity and showed a positive patellar compression test. Other inclusion criteria were symptom of patellofemoral pain for at least six months, anterior pain during or after at least two of the following activities: prolonged sitting, going up or down stairs, squatting, kneeling, running and jumping and an insidious onset of symptoms unrelated to a traumatic incident [15]. Participants were excluded if they showed signs or symptoms of any other knee pathology or injury.

Procedure: Before the evaluation, the subjects signed an informed consent form. In the first and last sessions, the following elements were evaluated: pain, knee proprioception and Q-angle for Lowe limbs.

Pain was measured using McGill scale with values between 0 and 10 cm. McGill pain scale can be used to evaluate a person experiencing pain. It can be used to monitor the pain over time and to determine the effectiveness of any intervention [16].

The Q-angle was measured with a standard 360° goniameter, with the patient in the supine position, feet in the neutral position and relaxed quadriceps femoralis muscle [12].

We have used the repositioning error in order to measure knee proprioception. The test measures the accuracy of position replication and can be conducted actively or passively in both open and closed kinetic chain positions. In this study we have done the test passively with the patient in the prone position.

Small reflective markers approximately 1 cm in diameter were applied to the right and left ASIS and midpoint of the right and left patella and the middle of the right and left tibia tubercle for the measurement of Q-angle. The midpoint of the patella was determined by the intersection of a line from the medial to lateral patella and a line from the inferior to superior patella. To convert the Q-angle values the angles were subtracted from 180 degrees. Interarater reliability was assessed for all 34 patients by repeating the measurement of the Q-angle and Repositioning Error and pain scale on 3 different days.

G1 performed mini squat exercise (CKC) with the patient in standing position, legs at full extension and then bending the knees with 30 degrees flections with a load of 1 kg in each hand.

G2 performed quadriceps femoralis muscle strengthening (OKC) seated on a chair with the trunk and thighs flexed at 90 degrees. The exercise was completed by performing an extension and flections movement of the leg at 90-45 degrees with a load of 1 kg on each foot.

Statistical Analysis: The statistical analysis was conducted by adopting a 5% significance level. It was carried out in two phases. A comparison of variables before and after treatment on each group and between independent groups was done. All the variables were analyzed as to normality using the Anderson-Darling test. The data were parametric. Between the groups, the following variables were assessed: pain severity, Q-angle and knee proprioception. Initially, variance homogeneity was investigated by using the Lavene's test. When homogeneity was present, the t-test was employed, paired t-test to evaluate the effects of performing exercise program in each group and independent t-test for independent samples. For demographic data such as: age, mass, height and body mass index (BMI) the same procedure described on previous paragraph was performed for measurements obtained prior to treatment.

RESULTS

Table 1 show the results of G1 and G2, where a statistically significant difference ($p<0.05$) was found for the variables of pain and the Q-angle after treatment while showed unchanged knee proprioception. The analysis of demographic data did not evidence statistically significant difference between groups. These data suggest that treatments for PFS patients have no evidences of differences between OKC and CKC exercises.

Table 1: Average and standard deviation of the values obtained before and after treatment for G1 and G2 P values (n=17) at (P<0.05).

	Before		After		P	
Variables	G1	G2	G1	G2	G1	G2
McGill scale	7.4118	7.8824	1.82	1.88	0.000	0.000
Right Q-Angle (degrees)	19.000	19.9412	17.7059	18.2588	0.000	0.000
Left Q-Angle (degrees)	19.2353	19.5882	17.8235	18.0882	0.001	0.000
Right Repositioning error (degrees)	92.3824	89.1176	90.0882	89.000	0.141	0.918
Left Repositioning error (degrees)	89.5588	88.7059	89.7353	89.4118	0.907	0.474

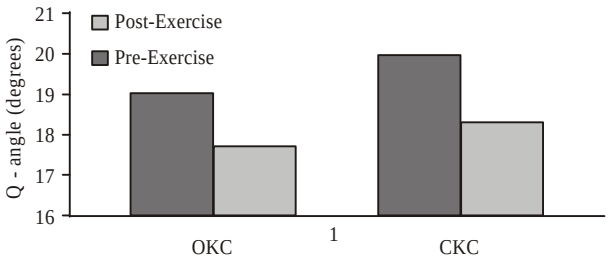

Fig. 1: Sshows a significant decrease in the right Q-angle in both OKC (mean±SD, 17.7±1.6°) and CKC (mean±SD, 18.2±0.7°) after eight weeks training

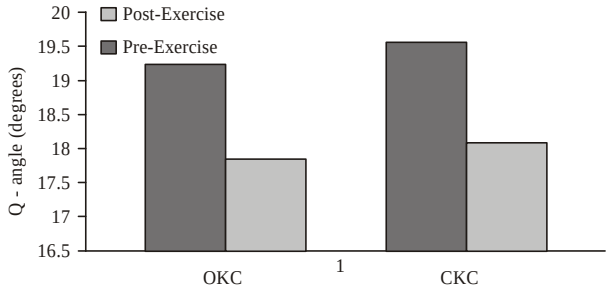

Fig. 2: Shows a significant decrease in the left Q-angle in both OKC (mean±SD, 17.8±1.6°) and CKC (mean±SD, 18.0±1.4°) after eight weeks training

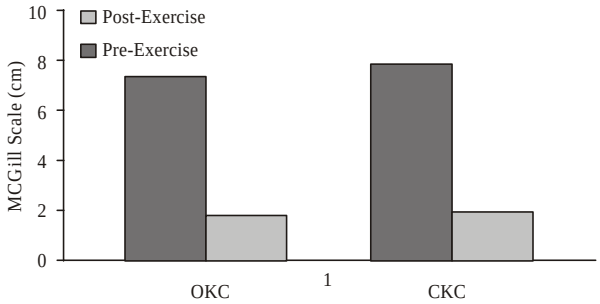

Fig. 3: Shows a significant decrease in pain level in both OKC (mean±SD, 1.8±1.4°) and CKC (mean±SD, 1.8±1.1°) after eight weeks training

DISCUSSION

The results showed a significant decrease in pain level in both CKC and OKC Exercises (<0.05). Cobral CMN [1] also observed a significant decrease in pain level in closed kinetic chain exercises. Our findings showed a significant improvement in Q-angle, in both groups. Some literature studies have also assessed the Q-angle in patients with PFS and found the same result. Tunay *et al.* [17] found a significant Q-angle improvement in patients submitted to different treatments regarding Q-angle values; these were very similar to our results. Different results were found by Sacco *et al.* [18], who did not found differences for Q-angle after treatment for 5 weeks. The procedure for measuring Q-angle can also cause variation between values. In our assessment, the patient was positioned at rest, while the studies by Tunay *et al.* [17] and Sacco *et al.* [18], do not describe patients positioning or the quadriceps femoralis muscle status. In this study the mean Q-angle values before treatment are very close to the one found by Boucher *et al.* [19] and Cabal Cm [1], who found mean values of approximately 21 degrees in PFS patients.

Finally, the results showed no significant change in the impairment of knee joint position sense. Khalkhal M [20], in the study of effects of CKC and OKC on PFS patients achieved the same results as this study and found no significant change in the impairment of knee joint position sense by OKC and CKC exercises.

CONCLUSION

These data suggest that treatments based on exercises for quadriceps femoris strengthening produced improvement on a number of PFS signals and symptoms such as pain and Q_angle with no evidences of differences between OKC and CKC exercises. Finally, regarding lower limb realignment, both treatments were shown to be effective.

REFERENCES

1. Cabral, CMN., AMO. Melin, ICN. Sacco and A.P. Marques, 2008. Phisical therapy in patellofemoral syndrome patients:Comparision of open and closed kinetic chain exercises, Acta Orthop. Bras., 16(3): 180-185.
2. Aglieffi, P., J. Insall and G. Cerrulli, 1983. "Patellar pain and incongruence measurements of incongruence", Clin. Orthop., 176: 217-224.
3. Thomee, R.A., 1997. Comprehensive treatment approach for patellofemoral pain syndrome in young women. Phy. Ther., 77:(1): 690-703.
4. Coqueiro, KRR., D. Bevilaqua-Grossi, F. Berzin, B. Seares, C. Candolo and V. Monteiropedro, 2005. Analysis on the activation of the VMO and VLL muscles during semisquat exercises with and without hip adduction in individuals with patellofemoral pain syndrome. J. Electromyogr. Kinesiol., 15: 596-603.
5. Tunay ,V.B., N. Ergun, G. Baltaci, S. Tunay and Z. Erden, 2003. Treatment of patellar tracking and pain in patellofemoral malalignment : Conservative versus surgery. Pain. Clin., 15(1): 85-92.
6. Schulthies, S., R. Francis, A. Fisher, De. Van and K. Graff, 1995. Does the Q-angle reflect the force on the patella in the frontal plane? Phys. Ther., 75: 24-30.
7. Caylor, D., R. Fites and T. Worrell, 1993. The relationships between quadriceps angle and anterior knee pain syndrome. J. Orthop Sports Phys Ther, 17: 11-16.
8. Grelsamer, R.P. and J.R. Klein, 1998. The biomechanics of the patellofemoral joint. J. Orthop Sports. Ther., 28: 286-298.
9. Woodland, L. and R. Ancis, 1985. Parameters and comparison of the quadriceps angle of college-aged men and women in the supine and standing positions. Am. J. Sports. Med., 14: 345-366.
10. Beck, J. and B. Wilder Muth, 1985. " The female athlete's knee", Clin. Sports. Med., 4: 345-366.
11. Horton, M., T. Hall, 1989. Quadriceps femoris muscle angle: normal values and relationships with gender selected skeletal measures .Phys. Ther., 69: 897-901.
12. Cowan, S.M., P.W. Hodges, K.L. Bennell and K.M. Crossley, 2002. Altered Vastii recruitment when people with patellofemoral pain syndrome complete a postural task. Archives of Physical Med and Rehabilitation. 83: 989-95.
13. Hvid, I. and L. anderson, 1982. The quadriceps angle and its relation to femoral torsion .Acta Orthop Scand, 53: 577-579.
14. Huberti, H. and W. Hayes, 1984. Patellofemoral contact pressures: the influence of Q-angle and tendofemoral contact. J. Bone. Joint. Surg. Am., 66: 715-724.
15. Jen, S., M. Schenkman and P. Riley, 1990. Reliability of a clinical assessment of the sit-to-stand movement. Phy. Ther., 70: 511-520.
16. Melzak, R., 1975. The McGill pain questionnaire major properties and scoring methods. Pain, 1: 277-299.
17. Tunay, V.B., G. Baltaci, S. Tunay and N.A. Ergun, 2003. Comparison of different treatment approaches to patellofemoral pain syndrome. Pain. Clin., 15(10: 79-84.
18. Sacco, ICN., GK. Knno, G.B. Rojas, A.C. Arnone, A.C. Passaro, A.P. Marques, *et al.* 2006. functional and EMG responses to a physical treatment in patellofemoral syndrome patients. J. Electromyogr kinesiol., 16: 167-74.
19. Boucher, J.P., M.A., King, R. Lefebvre, A. Pepin, 1992. "Quadriceps femoris muscle activity in patellofemoral pain syndrome, Am. J. Sports. Med., 20: 527-32.
20. Khalkhali, M., M. Ghasemi, Z. Talebian and M. Abooei, 2004. The study of efficiency of open and closed kinetic chain exercises on knee proprioception of healthy females. J. of Med and Health services of Shahid B. Eheshti Uni., 28(2): 115-119.