Effect of Knee Brace on VMO and VLEMG Activity During Five Knee Exercises

Olfat Mohamed, PhD. PT.
Department of Physical Therapy, California State University, Long Beach.

ABSTRACT

Patellofemoral pain is one of the most common knee complaints in young athletes. One of the several proposed etiologies of PFP is poor vastus medialis oblique (VMO) control. Wire electrodes were used to determine if wearing the On-Track brace during exercise improves VMO intensity and timing in asymptomatic subjects. Twenty subjects without any history of patellofemoral pathology participated. VMO and vastus lateralis (VL) muscle EMG activity was recorded using intramuscular wire electrodes during five exercises. We found no significant differences in the timing and intensity of EMG activity of the VMO muscle, VL muscle, or the VMO/VL EMG ratio due to the different components of the On-Track brace. Significant differences between all exercises were found in intensity of EMG activity for both VMO and VL muscles except for step up and single leg squat. Any improvement in PFP with the brace may be due to mechanisms other than altering muscle activity.

INTRODUCTION

Patellofemoral pain syndrome (PFPS) is one of the most common knee problems among young athletes[10,12]. Patellofemoral pain is generally described as retropatellar or peripatellar and diffused. The pain typically increases during high demand activities such as running, jumping, squatting, and going up and down stairs[4,9,23]. Lateral tracking of the patella is one of the common causes of PFPS[17]. Lateral tracking is hypothesized to result from inadequate strength or delayed onset of the VMO. This hypothesis is based on the medial alignment of the VMO fibers as they attach to the patella. Because of this alignment, the VMO produces a large medial pull on the patella and has been shown to counteract the VL to prevent lateral subluxation of the patella[21].

Bracing and taping are used to affect static and dynamic forces on the patella in persons with PFPS[6,30,37-39]. They are designed to realign the patella medially and have been shown to alleviate symptoms in most patients with PFP[2,11,20,36,38,22,25,33]. No evidence of change of patellar alignment or tracking during knee movement was reported in the taping or bracing studies.

Taping or bracing is also proposed to increases the recruitment of the VMO compared to the VL muscle. Earlier timing and/or increased intensity of the VMO is hypothesized to be due to sensory feedback from contact of the tape or brace on the skin[7,15,20,44]. This theory is based on results of research that demonstrated that skin sensory stimulation through brushing, icing, vibration, and deep pressure facilitated recruitment of the muscle stimulated[3,5,8,16,32]. For this theory to be tested, the tape or brace would need to be selectively applied to the VMO muscle.

A unique brace, part of the On Track (System, is designed to selectively stimulate the skin over the VMO muscle in patients with PFP (Fig 1). The system consists of the On Track brace (OTB) and videotape that demonstrates how to apply the brace and perform several knee exercises. The OTB has three components: a neoprene knee sleeve, a neoprene pull strap, and a plastic VMO "activator". The plastic tip of the "activator" is placed on the skin over the VMO muscle belly to facilitate VMO activation through skin stimulation[14]. While several investigators have studied the effect of bracing on patellar alignment and quadriceps EMG activity[28,30,31,37,39,43], none was found that investigated the effect of adding a specific element for tactile stimulation like that offered by the OTB (the VMO "activator").

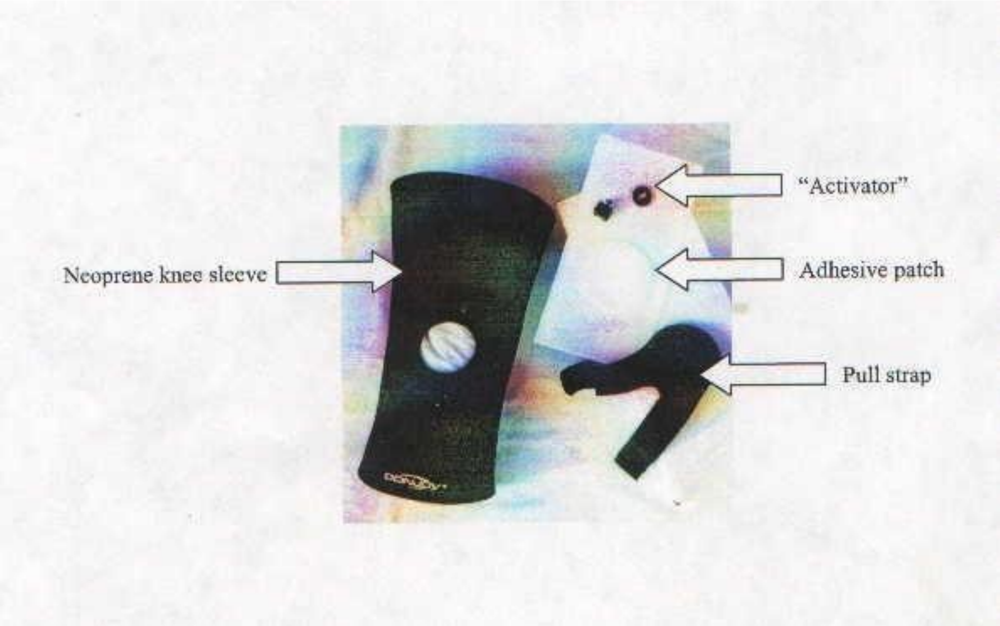


Fig. (1): The different components of the On Track® brace.

The purpose of our study was to determine the effect of different combinations of components of the OTB on the intensity and timing of the EMG activity of VMO and VL muscles and VMO/VL ratio during five exercises that are commonly used in the rehabilitation of patients with PFP. To control for the known variability of causes for PFP we conducted the study on persons without PFP as there is no evidence of sensory abnormality in this population that would cause a different response to tactile stimulation.

METHODS

Subjects

Twenty healthy volunteers (9 men and 11 women) with no history of PFP or surgeries of the lower extremities participated in the study. The mean age for the group was 27.7 years (SD, 5.8), mean body mass was 71.1 kg (SD, 8.81) and mean height was 164 cm (SD, 7.8). All subjects signed an institutional IRB approved consent to participate in the study.

Instrumentation

Dynamic EMG: Myoelectric activity of the VMO and VL muscles was sensed by pairs of 50-micron nylon-insulated, nickel-chromium alloy, wire electrodes. The paired wires, threaded through a single 1.5- inch, 25 gauge disposable needle, had the distal ends stripped of insulation, staggered and folded over the needle tip[1]. After insertion of the electrodes, the needle was withdrawn leaving the electrodes in place in the muscle. The proximal free ends of each pair of wires were stripped of insulation and secured to springs on a bipolar pre-amplifier taped securely to the subject's thigh. A common ground was affixed on the skin over the spine of a lumbar vertebra. EMG signals were transmitted from the pre-amplifiers to a MA-300® system "backpack" attached to a belt at the subjects waist. The EMG signal was then transmitted via an 18 m long, 3 mm diameter coaxial cable to the MA-300 EMG system[1] and then to an oscilloscope and a computer for viewing and recording data. The band pass filter of the pre-amplifiers was 20-1000 Hz, and A/D data acquisition rate for each channel was 2400 samples per second.

The Brace

The On Track® brace (OTB) consisted of three components: a neoprene sleeve, a neoprene, patellar alignment device with two pull straps, and a VMO "activator". The neoprene sleeve had a circular cut out for the patella, which allowed an adhesive knee patch placed over the patella to be exposed through the cut out. The patellar alignment device then attached to the Velcro® top of the exposed patch through the circular cut out with the pull straps extending medially. The straps were pulled medially to realign the patella and then attached to the neoprene sleeve. The "activator", a round plastic piece approximately 2 cm in diameter, was attached to the under surface of the brace over the VMO muscle. The brace was available in sizes ranging from x small to x-large.

Procedure

The subject's lower extremity used to kick a ball was used as the test limb. The skin over the VMO and VL muscles was cleaned with alcohol and intramuscular, wire electrode pairs were inserted into the VMO at mid-muscle belly and into the VL at approximately one third of the distance from top of the patella to the anterior superior iliac spine. The subject then contracted his muscle forcefully and his knee was passively flexed and straightened to minimize possible movement of electrodes in the muscle during exercise. Electrodes were attached to the pre-amplifiers and electrode placement into the quadriceps was confirmed by observing EMG activity on an oscilloscope during isometric quadriceps contraction at zero degrees flexion. Resting EMG was recorded for 5 seconds to establish baseline activity. Maximal testing (MMT) was then performed with the subject back lying, resting on both forearms with the test knee within 20 degrees of full extension and the hip flexed to approximately 60 degrees. Maximum manual resistance to knee extension was applied proximal to the ankle while investigators verbally encouraged the subject during EMG recording.

The size of neoprene brace that fit the subject's thigh firmly without restricting motion was chosen for each subject. Then the following donning procedure was used for the application of all components. Before application of the neoprene sleeve, the self-adhesive knee patch was placed on the knee so that the circular Velcro® top was positioned over the patella. The neoprene sleeve then was applied, the neoprene patellar alignment device attached to the taped Velcro® and the two extended straps pulled medially and attached by Velcro® to the neoprene sleeve. The plastic "activator" was attached to the under surface of the neoprene sleeve over the VMO muscle.

Five exercises and five bracing conditions were randomized between subjects using a random numbers table. Bracing conditions consisted of no brace, neoprene sleeve only, sleeve and strap, sleeve and "activator", and sleeve with strap and "activator". The exercises were double leg squat, single leg squat, step up, step down, and quad set. Each exercise lasted 5 seconds.

Quad set - Subjects performed isometric quad sets in the long-sitting position with the hip at about 90 degrees of flexion and neutral rotation, supporting themselves on their hands.

Step up - Subjects placed the foot of the test limb on a 23 cm stool. They completely shifted their weight onto the test limb during the first two seconds, and then lifted the contralateral limb while rising up onto the step, extending the test knee during the final three seconds.

Step down - Subjects stood on their test limb on a 23 cm stool. The opposite limb was held off the floor slightly in front of the stool.

Double Leg Squat - The subject was positioned near the wall at a distance that allowed comfortable squatting while maintaining vertical back alignment. During the first three seconds of the trial, the subject slowly flexed both knees to 60 degrees and held that position for the final two seconds.

Single Leg Squat - Conditions were identical to the double leg squat except that the contralateral limb was flexed and non-weight-bearing.

Data Reduction

Raw EMG was rectified and integrated each one fiftieth of a second. Noise levels were established by the resting trail. Any subsequent EMG recording of greater than 5% of resting level was processed as EMG. The highest half-second of EMG for each muscle of the maximum manual resistance trial (MMT) was used to establish a normalization factor. EMG of exercise trials was divided by the normalization factor resulting in EMG expressed as percent MMT. The normalized data for each trail was averaged over the 5 seconds for each muscle The VMO/VL ratio was calculated from the average, normalized EMG of each trial. Data processing used EMG analyzer software[2]. Onset timing of EMG was determined by additional custom-designed B&L Engineering, Inc. software. The onset of the first packet of activity with an amplitude greater than 5% MMT, lasting at least .05 seconds, was considered as the onset of activity of the muscle during each exercise.

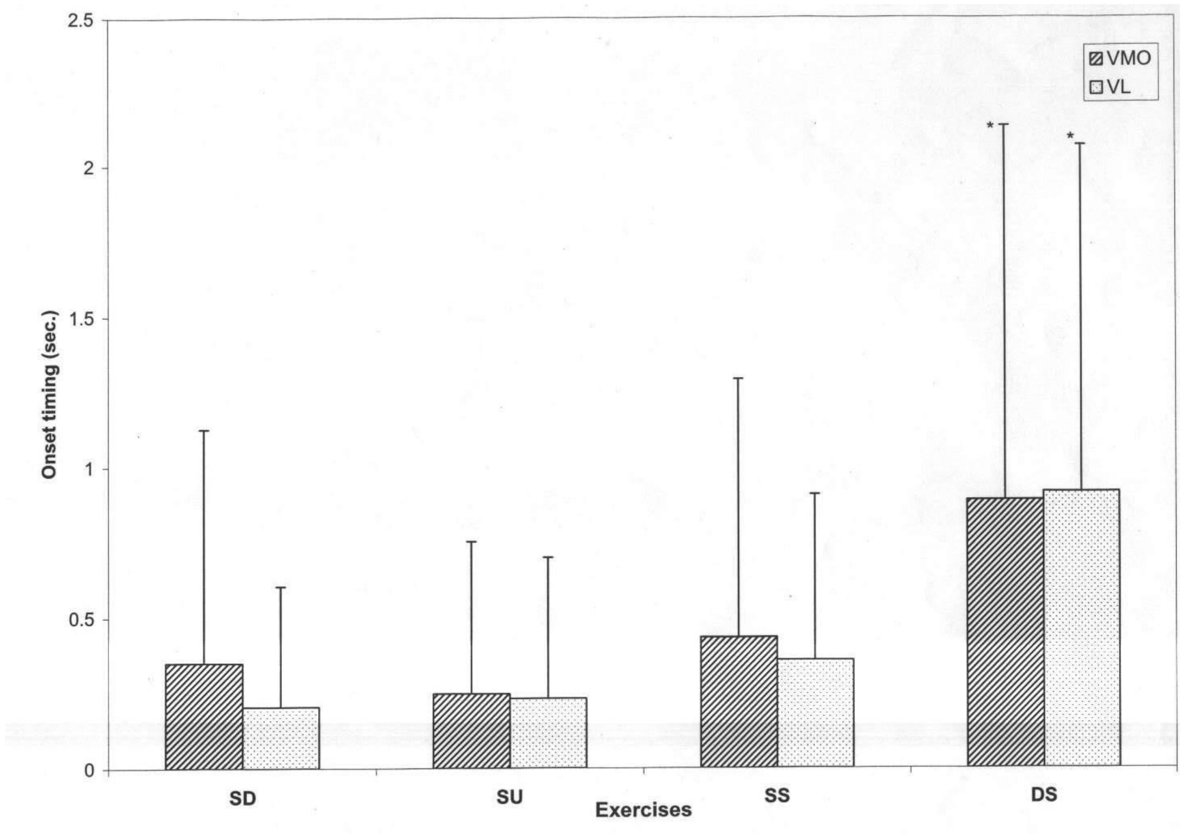
Statistical Analysis

Repeated measures multiple analysis of variance (MANOVA) was used to determine differences in EMG intensity and timing of the VMO and VL as well as VMO/VL ratios between brace conditions and between exercises. The alpha level was set at 0.05. Bonferroni adjustment of the P value was used for post hoc testing.

RESULTS

EMG Intensity

We found no significant differences in intensity of EMG activity of the VMO muscle, VL muscle, or the VMO/VL EMG ratio due to brace condition (sleeve alone, sleeve with strap, sleeve with "activator", sleeve with strap and "activator", no brace) (Fig.2). Interaction of brace condition and exercise also was not significant.



SD = step down SU = step up SS = single squat DS = double squat
* Significantly later than all other exercises P<.05

Fig. (2): VMO and VL EMG (%MMT) during step down.

A significant difference was found in intensity of EMG activity of both VMO and VL muscles due to exercise. Post hoc testing showed significant differences in intensity of VMO and VL muscle activity between all exercises except between the step up and single leg squat (Table 1, Fig. 3). The ranking of exercises from highest to lowest EMG intensity was the same for the VMO and VL muscles. The only exercise that had a significantly different VMO/VL muscle activity ratio from other exercises was the quad set (Table 1). The quad set exercise elicited relatively more VL activity (VMO/VL ratio=1.13) compared to all other exercises (mean VMO/VL ratio=1.34) except the double limb squat.

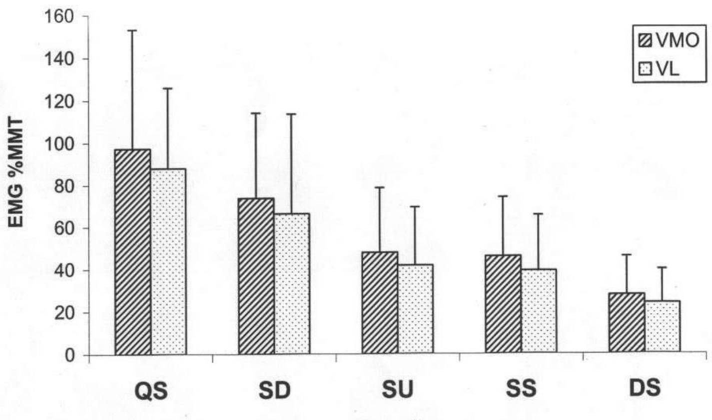
Table (1): Intensity of VMO, VL (%MMT) and VMO/VL Ratio During the five knee exercises.

Exercise	VMO		VL		VMO/VL	
	Mean	SD	Mean	SD	Mean	SD
QS	97[bcde]	56	88[bcde]	38	1.13[bcd]	.45
SD	74[acde]	40	66[acde]	47	1.32[a]	.83
SU	48[abe]	30	42[abe]	27	1.32[a]	.86
SS	46[abe]	28	39[abe]	26	1.39[a]	1.15
DS	28[abcd]	18	24[abcd]	15	1.43[a]	1.43

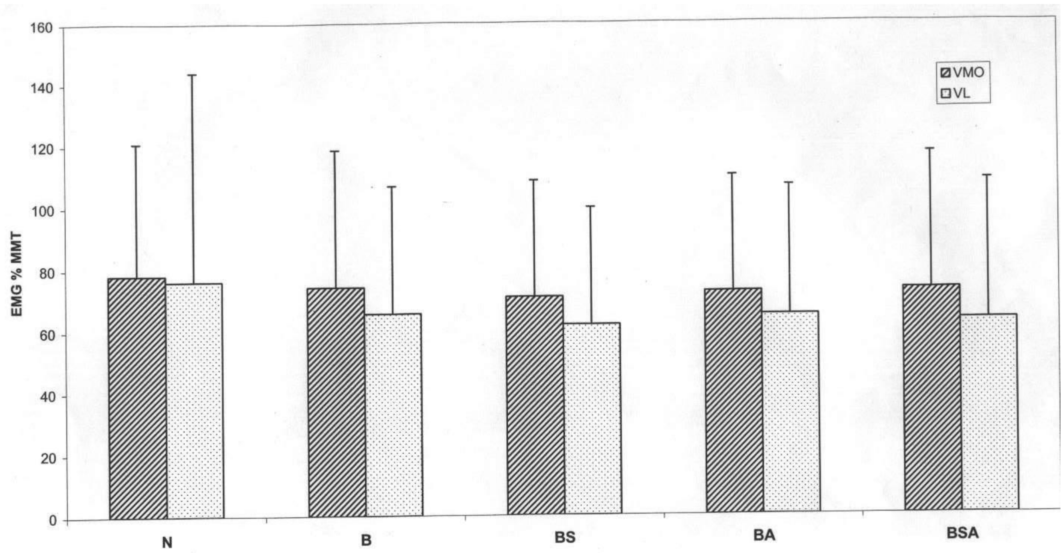
Quad set (QS), step down (SD), step up (SU), double limb squat (DS), and single limb squat (SS)
[a] significantly different from QS
[b] significantly different from step down
[c] significantly different from step up
[d] significantly different from single squat
[e] significantly different from double squat

EMG timing

The quad set exercise was excluded from this comparison because recording started after the beginning of muscle activity. Onset of VMO and VL ranged from .20 seconds to .91 seconds after the beginning of the exercise. We found no significant difference in timing of EMG activity of either muscle due to brace condition or in the interaction between brace condition and exercise. There was, however, a significant difference in onset timing due to exercise (Fig. 3). Onset of both VMO and VL activity was significantly later in the double leg squat than all other exercises (Fig. 4).



Exercise
QS = quad set SD = step down SU = step up SS = single squat DS = double squat
Fig. (3): VMO and VL EMG activity (%MMT) during knee exercises.



Bracing Conditions

N: no brace B: brace only BS: brace & strap BA: brace & activator BSA: brace strap &

Fig. (4): VMO and VL onset timing during knee exercise.

DISCUSSION

We chose subjects without PFP because proposed etiologies of PFP do not include sensory pathology, we expected that the EMG response to the tactile and mechanical effect of the On Track Brace® would be similar in the two groups. Furthermore, we chose subjects without PFP to minimize confounding the results with mechanical factors such as patellar malalignment or physiological factors such as pain.

Effect of Brace on EMG Intensity

External patellar support has been shown to improve symptoms and function in patients with PFP[2,11,20,36,38,42]. Our results do not support the claim that the On Track Brace® facilitates VMO activity through tactile stimulation provided by the VMO "activator" placed on the skin over the VMO muscle. Other potential sources of tactile stimulation (the neoprene cuff, the adhesive Velcro patch placed on the patella and the patellar strap) also failed to alter the intensity of VMO or VL muscle activity or the VMO/VL activity ratio.

The results of the present study agree with those of Nemeth et al., who studied volitional muscle activity during functional exercises with a compressive knee brace, a condition similar to our neoprene sleeve. They found no significant effect of the compressive brace on EMG activity of the vastus medialis, biceps femoris, semitendinosus, semimembranosus or gastrocnemius muscles during downhill skiing in subjects with ACL injuries when compared to skiing without the brace[31].

The strap component of the On-Track brace was designed to position the patella medially in the trochlear groove by employing a concept similar to McConnell's patellar taping[25]. The application of the patellar strap did not cause any changes in the EMG activity of the VMO, VL or the VMO/VL muscle activity ratio during the 5 tested exercises.

These results agree with those of Powers et al. and of Cerny who reported no effect of medial patellar taping on the level of activity of either the VMO or VL muscles or the VMO/VL muscle activity ratio during exercise in subjects with or without PFP[6,36].

Effect of On-Track Brace on Timing of EMG

We found no significant differences in onset timing of the VMO or VL muscles between any of the brace conditions regardless of exercise. The VMO "activator", proposed to cause earlier recruitment of the VMO due to tactile stimulation, failed to show such an effect on timing in our subjects.

Effect of exercise on EMG intensity

We investigated one open chain exercise (quad set) commonly used in the acute stage of PFP and four closed chain exercises (step up, step down, single squat and double squat). We found significant and similar differences in the intensity of muscle activity of both the VMO and VL muscles between exercises demonstrating that some exercises recruited more activity of both muscles than other exercises.

The finding that the quad set exercise showed the highest VMO and VL EMG activity (97 % and 88 % MMT, respectively) agrees with several other studies6,19,26,40. For example, the quad set had the greatest VMO and VL activity when compared to several variations of straight leg raise exercises[19,40]. Quad set also recruited higher activity when compared to isometric contraction at knee flexion angles of 15 and 60° and compared to knee extension from 300 to full extension in persons with PFP[6].

Another factor that may have contributed to the greater intensity of quad set activity in the present study is that the quad set exercise was associated with the shortest quadriceps muscle length. Studies on the relationship of EMG and muscle length demonstrated increased EMG activity with shorter muscle lengths at the same intensity of effort [Lunnen, 1981 #178; Andriacchi, 1984 #177;[27].

The step down exercise had the greatest EMG activity of the closed chain exercises (VMO = 78% MMT; VL = 76% MMT). This finding is explained by the greater quadriceps demand for this exercise than for the others. The step down exercise required subjects to unilaterally bear weight with the knee flexed to greater than 90 degrees for 3 seconds, whereas the single and double leg squats were only performed to and held for 3 seconds at 60 degrees flexion. The step up exercise required subjects to be flexed greater than 90 degrees for a very short period of time as the weight-bearing knee was fully extended within 3 seconds.

The findings of the present study are in agreement with several other studies that also found that quadriceps EMG activity increased as knee flexion angles increased in weight bearing[6,24,34].

The third highest EMG activity was found in the step up and the single leg squat exercises, which did not show significantly different EMG activity from each other. The single leg squat exercise required eccentric and isometric quadriceps contraction, whereas the step up exercise required a concentric contraction. Concentric contractions produce less force than isometric and eccentric contractions and concentric contractions produce more EMG activity compared to isometric and eccentric contractions for the same force output[18,24,29]. If joint angles and torque demand were similar for both step up and single leg squat exercises in this study, the step up would produce more quadriceps activity than the single leg squat[18,24,29]. No differences in EMG activity were seen between the exercises because the joint angles and torque demand were not similar. The step up exercise required a controlled ascent onto a stool, beginning the single leg support phase of the exercise in a position of high quadriceps demand (flexion of greater than 90 degrees) but transitioning to a position of low demand (full extension) within 3 seconds, whereas the single leg squat exercise required a 3 second descent from full extension into 60 degrees flexion, followed by a 2 second hold at 60 degrees. The single leg squat exercise, therefore, required 2 seconds longer support on a single leg than the step up exercise. These 2 seconds required isometric activity in a relatively demanding position of 60 degrees flexion. The combination of isometric and eccentric activity during the more difficult single leg squat resulted in an equivalent amount of EMG activity as the concentric step up exercise.

That the double leg squat to 60 degrees of knee flexion generated the least EMG activity of all the closed chain activities is expected as subjects could equally distribute the torque demand between both legs.

Effect of exercises on VMO/VL Intensity Ratio

The mean ratio obtained in all tested exercises ranged from 1.13 to 1.43 (Table 1). These ratios are similar to those previously reported for asymptomatic subjects[6,35,41]. The quad set exercise had the least variable ratio with a standard deviation of .45 compared to .83 to 1.43 for the other exercises suggesting that encouragement to produce maximum force of the quadriceps was consistent. The double leg squat, which was the least challenging exercise, was associated with the highest variability indicating differences in strategies employed between subjects in achieving this relatively easy dynamic task.

The significantly lower VMO/VL ratio (relatively higher VL activity) for the quad set exercise than for the closed chain exercises requiring single limb flexion (step up, step down, or the single leg squat) in this study doesn't agree with that reported by Powers, who found that the activity of the VMO muscle increased relative to the VL during terminal extension in persons with PFP[34]. He speculated that this increase in VMO activity is related to its function as a medial patellar stabilizer to prevent lateral patellar displacement during terminal knee extension when the patella sits above the trochlear groove and thus has lost the passive stabilization of the lateral wall of the groove. The present study is different from that of Powers in that we studied asymptomatic subjects who had no known lateral tracking problem and that we compared the zero extension position (quad set) to four closed chain exercises, which involved more flexed knee positions than his maximum flexion of 45 degrees. We found no significant differences in VMO/VL ratio between the closed chain exercises in subjects without PFP. This supports findings by other investigators who studied subjects with and without PFP and reported no or minimal differences in VMO/VL ratio between open or closed chain exercises[6,19,26,35,38].

The studies on VMO/VL ratio, therefore, suggest that the VMO muscle cannot consistently be preferentially activated by exercise. Improvement in symptoms in persons with PFP as a result of exercise cannot be attributed to selective activation of the VMO muscle.

Effect of exercise on timing of EMG

Timing of onset of VMO and VL muscles has been studied because some studies have shown delayed onset of the VMO muscle reflexes in patients with compared to subjects without PFP[11,13,45].

Our results of no differences in onset of EMG due to exercise are similar to those of Powers et al., who found no differences in timing of onset or cessation of EMG between the vasti muscles during stair climbing and walking on a ramp in persons with and without PFP[35]. They concluded that timing differences do not exist between the VMO and VL in subjects with PFP and therefore do not contribute to patellofemoral dysfunction.

REFERENCE

1- Basmajian, J. and DeLuca, C.: Muscles Alive: Their functions revealed by electromyography (ed 5th ed.). Baltimore, MD, Williams & Wilkins, 1985.
2- Bockrath, K.: Effects of patella taping on patella position and perceived pain. Official Journal of the American College of Sports Medicine March 1993:989, 1993.
3- Bosco, C., Cardinale, M. and Tsarpela, O.: Influence of vibration on mechanical power and electromyogram activity in human arm flexor muscles. Eur J Appl Physiol Occup Physiol 79:306, 1999.
4- Broom, M.J. and Fulkerson, J.P.: The Plica Syndrome: A new perspective. Orthopedic Clinics of North America 17:279, 1986.
5- Burke, J.R., Schutten, M.C., Koceja, D.M. and Kamen G: Age-dependent effects of muscle vibration and the Jendrassik maneuver on the patellar tendon reflex response. Arch Phys Med Rehabil 77:600, 1996.
6- Cerny, K.: Vastus medialis oblique/vastus lateralis muscle activity ratios for selected exercises in persons with and without patellofemoral pain syndrome [see comments]. Phys Ther., 75:672, 1995.
7- Cherf, J. and Paulos, L.E.: Bracing for patellar instability. Clin Sports Med 9:813, 1990.
8- Curry, E.L. and Clelland, J.A.: Effects of the asymmetric tonic neck reflex and high-frequency muscle vibration on isometric wrist extension strength in normal adults. Phys Ther., 61:487, 1981.
9- Doucette, S. and Globe, E.M.: The effect of exercise on patllar tracking in lateral patellar compression syndrome. The American Journal of Sports Medicine, 20:434, 1992.
10- Fulkerson, J.P. and Shea, K.P.: Current Concepts Review: Disorders of patellofemoral alignment. Journal of Bone and Joint Surgery 72-A:1424, 1990.
11- Gilleard, W., McConnell, J. and Parsons, D.: The effect of patellar taping on the onset of vastus medialis obliquus and vastus lateralis muscle activity in persons with patellofemoral pain. Phys Ther., 78:25, 1998.
12- Goodfellow, J., Hungerford, D.S. and Woods, C.: Patello-femoral joint mechanics and pathology. 2. Chondromalacia patellae. Journal of Bone and Joint Surgery, 58-Br:291, 1976.
13- Grabiner, M.D., Koh, T.J. and Draganich, L.F.: Neuromechanics of the patellofemoral joint. Med Sci Sports Exerc., 26:10, 1994.
14- Grace, K.: Treatment of patellofemoral dysfunction. Phys Ther Products May/June, 1998.
15- Greenwald, A.E., Bagley, A.M., France, E.P., Paulos, L.E. and Greenwald, R.M.: A biomechanical and clinical evaluation of a patellofemoral knee brace. Clin Orthop., 187, 1996.
16- Gurfinkel, V.S., Levik, Y.S., Kazennikov, O.V. and Selionov, V.A.: Locomotor-like movements evoked by leg muscle vibration in humans. Eur J Neurosci., 10:1608, 1998.
17- Insall, J.: "Chondromalacia Patellae": Patellar malalignment syndrome. Orthopedic Clinics of North America, 10:117, 1979.
18- Isear, J.A., Jr., Erickson, J.C. and Worrell, T.W.: EMG analysis of lower extremity muscle recruitment patterns during an unloaded squat. Med Sci Sports Exerc 29:532, 1997.

19- Karst, G.M. and Jewett, P.D.: Electromyographic analysis of exercises proposed for differential activation of medial and lateral quadriceps femoris muscle components. Physical Therapy, 73:286, 1993.
20- Kowall, M.G., Kolk, G., Nuber, G.W., Cassisi, J.E. and Stern, S.H.: Patellar taping in the treatment of patellofemoral pain. A prospective randomized study. Am J Sports Med., 24:61, 1996.
21- Lieb, F.J. and Perry, J.: Quadriceps function. An anatomical and mechanical study using amputated limbs. J Bone Joint Surg Am, 50:1535, 1968.
22- Lysholm, J., Nordin, M., Ekstrand, J. and Gillquist, J.: The effect of a patella brace on performance in a knee extension strength test in patients with patellar pain. Am J Sports Med., 12: 110, 1984.
23- Malek, M.M. and Mangine, R.E.: Patellofemoral pain syndrome: a comprehensive and conservative approach. J Orthop Sports Phys Ther., 2: 108, 1981.
24- McCaw, S.T. and Melrose, D.R.: Stance width and bar load effects on leg muscle activity during the parallel squat. Med Sci Sports Exerc., 31: 428, 1999.
25- McConnell, J.: The management of chondromalacia patellae. A long term solution. Aust J Physiother 32:215, 1986.
26- Mirzabeigi, E., Jordan, C., Gronley, J.K., Rockowitz, N.L. and Perry, J.: Isolation of the vastus medialis oblique muscle during exercise. Am J Sports Med., 27:50, 1999.
27- Mohamed, O., Perry, J. and Hislop, H.: Relationship between wire EMG activity, muscle length, and torque of the hamstrings. Clin Biomech (Bristol, Avon) 17:569, 2002.
28- Moller, B.N. and Krebs, B.: Dynamic knee brace in the treatment of patellofemoral disorders. Arch Orthop Trauma Surg., 104: 377, 1986.
29- Moritani, T., Muramatsu, S. and Muro, M.: Activity of motor units during concentric and eccentric contractions. American Journal of Physical Medicine, 66: 338, 1988.
30- Muhle, C., Brinkmann, G., Skaf, A., Heller, M. and Resnick, D.: Effect of a patellar realignment brace on patients with patellar subluxation and dislocation. Evaluation with kinematic magnetic resonance imaging. Am J Sports Med., 27:350, 1999.
31- Nemeth, G., Lamontagne, M., Tho, K.S. and Eriksson, E.: Electromyographic activity in expert downhill skiers using functional knee braces after anterior cruciate ligament injuries. Am J Sports Med., 25:635, 1997.
32- Nishikawa, T. and Grabiner, M.: Peroneal motoneuron excitability increases immediately following application of a semirigid anlkle brace. JOSPT, 29: 1169, 1999.
33- Palumbo, P.M.: Dynamic patellar brace: A new orthosis in the management of patellofemoral disorders. Am J Sports Med., 9: 45, 1981.
34- Powers, C.M.: Patellar kinematics, part I: the influence of vastus muscle activity in subjects with and without patellofemoral pain. Phys Ther., 80:956, 2000.
35- Powers, C.M., Landel, R. and Perry, J.: Timing and intensity of vastus muscle activity during functional activities in subjects with and without patellofemoral pain. Physical Therapy, 76:946, 1996.
36- Powers, C.M., Landel, R., Sosnick, T., Kirby, J., Mengel, K., Cheney, A. and Perry, J.: The effects of patellar taping on stride characteristics and joint motion in subjects with patellofemoral pain. J Orthop Sports Phys Ther., 26: 286, 1997.
37- Powers, C.M., Shellock, F.G., Beering, T.V., Garrido, D.E., Goldbach, R.M. and Molnar, T.: Effect of bracing on patellar kinematics in patients with patellofemoral joint pain. Med Sci Sports Exerc., 31:1714, 1999.
38- Salsich, G.B., Brechter, J.H., Farwell, D. and Powers, C.M.: The effects of patellar taping on knee kinetics, kinematics, and vastus lateralis muscle activity during stair ambulation in individuals with patellofemoral pain. J Orthop Sports Phys Ther., 32: 3, 2002.
39- Shellock, F.G.: Effect of a patella-stabilizing brace on lateral subluxation of the patella:

assessment using kinematic MRI. Am J Knee Surg., 13: 137, 2000.

40- Soderberg, G.L. and Cook, T.M.: An electromyographic analysis of quadriceps femoris muscle setting and straight leg raising. Phys Ther., 63: 1434, 1983.

41- Souza, D.R. and Gross, M.T.: Comparison of vastus medialis obliquus: vastus lateralis muscle integrated electromyographic ratios between healthy subjects and patients with patellofemoral pain. Phys Ther., 71: 310, 1991.

42- Timm, K.E.: Randomized controlled trial of Protonics on patellar pain, position, and function. Med Sci Sports Exerc., 30: 665, 1998.

43- Villar, R.N.: Patellofemoral pain and the infrapatellar brace. A military view. Am J Sports Med 13:313, 1985.

44- Werner, S., Knutsson, E. and Eriksson, E.: Effect of taping the patella on concentric and eccentric torque and EMG of knee extensor and flexor muscles in patients with patellofemoral pain syndrome. Knee Surg Sports Traumatol Arthrosc., 1: 169, 1993.

45- Witvrouw, E., Sneyers, C., Lysens, R., Victor, J. and Bellemans, J.: Reflex response times of vastus medialis oblique and vastus lateralis in normal subjects and in subjects with patellofemoral pain syndrome. J Orthop Sports Phys Ther., 24: 160, 1996.

الملخص العربي

تأثير جبيرة الركبة على النشاط الكهربي للجزء الداخلي والخارجي للعضلة الرباعية أثناء خمسة تمارين علاجية للركبة

ألام الركبة المزمنة من أكثر الألآم شيوعاً بين الرياضيين وهي تنتج من عدة أسباب منها عدم توازن النشاط بين الجزء الخارجي والجزء الداخلي للعضلة الرباعية ولهذا السبب يوصف للرياضيين الذين يعانون من هذه الألام ارتداء جبائر للركبة ومنها جبيرة "ontrack" التي استخدمت في هذه الدراسة ويزعم أن هذه الجبيرة تعيد توازن نشاط العضلة الرباعية .

أجريت هذه الدراسة لتحديد ما إذا كانت الجبيرة بأجزائها المختلفة قادرة على تغيير النشاط الكهربي للعضلة الرباعية والذي سجل باستخدام الأليكترود للأسلاك الدقيقة التي زرعت في الأجزاء المختلفة للعضلة بواسطة الأبر .

لأثبتت النتائج أن الجبيرة وحدها غير قادرة على إحداث تغيير في النشاط الكهربي للأجزاء المختلفة للعضلة الرباعية ولذلك لا يوجد مبرر لاستخدامها لهذا الغرض .