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JOINT MOBILIZATION CHANGES ACTIVATIONS IN GLUTEUS AND VASTI MUSCLES DURING FUNCTIONAL ACTIVITIES IN PEOPLE WITHOUT AND WITH PATELLOFEMORAL PAIN SYNDROME

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We aimed to examine whether patellofemoral joint mobilization altered the activation in vasti and gluteus muscles in people with and without PFPS during functional activities. A total of 40 young collegiate students with and without PFPS were recruited. After the intervention of patellofemoral joint mobilization, there were significant earlier activations of vasti muscles and delayed activation of gluteus muscles such as heel rise, step up and down and drop landing in people with PFPS compared to that of healthy controls ($p < 0.05$). Patellofemoral joint mobilization may immediately altered motor coordination of knee and hip muscles in people with and without PFPS during functional activities
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KEY WORDS: patellofemoral pain syndrome, joint mobilization, motor control, electromyography, vasti muscles.

INTRODUCTION: Patellofemoral pain syndrome (PFPS) is a common condition in the sporting and general populations, particularly when repetitive lower limb loading is involved (Holmes and Clancy, 1998). Although the cause of PFPS is multifactorial, altered motor behavior of the vasti muscles contributes to chronicity of pain episodes. Notably, a delay in activation of the vastus medialis obliquus (VMO) relative to the vastus lateralis (VL) (Hinman et al., 2002) and reductions in VMO activity during functional tasks (Ahmed et al., 1987) were observed. As these muscles are critical for the medial-lateral control of the patellar, changes in its coordination result in excessive lateral tracking of the patellar. Notably, studies have shown that interventions including patellofemoral taping (Cowan et al., 2002) can improve pain-associated changes in motor coordination of the vasti muscles in patients with PFPS. In addition, improved motor behavior is associated with improved pain and functional outcomes (Crossley et al., 2002; Tsao and Hodges, 2008). However, whether manual therapy intervention such as joint mobilization that aims to reduce lateral patellofemoral tracking can change motor coordination in individuals with PFPS remain unclear.

Mobilization of the patellofemoral joint is commonly implemented clinically for the management of patients with PFPS. The rationale underlying this approach is that mobilization of the patellofemoral joint can induce activation of afferent input upstream to spinal and supraspinal centers. This input can induce various pain inhibitory mechanisms including descending pain inhibition and spinal gating of pain (Wright, 2001). Randomized controlled trials have demonstrated that joint manual therapy intervention is effective for the management of musculoskeletal pain conditions including PFPS (Crossley et al., 2002; Hoving et al., 2006). However, no study has examined whether manual therapy of the patellofemoral joint can induce alterations in motor behavior of the vasti muscles during functional tasks.

The primary aim of this study was to examine whether patellofemoral joint mobilization changed the activation in vasti and gluteus muscles in people with and without PFPS such as stepping and landing.

METHODS: A total of 40 young collegiate students were participated in this study, which involved individuals between 18-25 years of age. It consisted of 10 subjects with PFPS and 30 young healthy controls. Electromyographic activity (EMG) of vastus medial lateralis (VMO), vastus lateralis (VL) and gluteus medius (GM) was recorded bilaterally using pairs of surface electrodes. The positions of sEMG electrodes for VMO and VL were based on previous study (Cowan et al 2001). For GM, we used the recommendations from SENIAM protocol (http://www.seniam.org) as the selection of sEMG electrodes. Motor coordination of these muscles were evaluated through assessment of temporal parameters of EMG during functional tasks including heel rock, heel raise, step up, step down and single leg landing. The primary outcome measure was onset of VMO EMG relative to VL on the symptomatic side. This was identified visually as the time of increase in EMG activity from baseline. In order to remove the potential for investigator bias, all data were presented individually without identification of the muscle, order of trials or whether the trials precede or follow the intervention. The reliability for the determination of EMG onset timing of the VMO and VL has been examined in 10 healthy subjects tested on two separate occasions and showed excellent intraclass correlation coefficient (0.91-0.96; (Cowan et al., 2001)). Fifteen repetitions of each task were performed in random order before and immediately following manual therapy intervention. Consistent with clinical practice, the manual therapy group received non-painful large amplitude passive mobilizations of the patellofemoral joint in a medial direction at a frequency of ~1.5 Hz (McConnell, 1996). Temporal measures of EMG were compared before and immediately after the intervention, and between the control and manual therapy groups, using a repeated measures analysis of variance (ANOVA).

RESULTS: There were significant decrease in activation of vasti and gluteus muscles during functional activities such as heel rise, heel rock, step up and down and drop landing in people with PFPS compares to that of healthy controls ($p < 0.05$, Table 1). After the intervention of patellofemoral joint mobilization, the activations of VMO and VL in both groups were significantly altered compared to the condition of pre-intervention in dynamic activities such as step down and drop landing ($p < 0.001$, Table 2).

VMO

Group	Heel Rock	Heel Rise	Step Up	Step Down	Drop Landing
PFPS	335.7(52.7)	358.0(127.6)	-85.5(185.3)	-129.2(214.2)	-81.8(110.6)
Healthy	319.0(8.8)	363.5(22.9)	-38.9(11.7)	-1.7(15.1)	-25.9(13.2)
P value	0.016	0.047	<0.01	<0.01	0.016

VMO-VL

Group	Heel Rock	Heel Rise	Step Up	Step Down	Drop Landing
PFPS	31.4(49.3)	86.4(57.9)	39.2(97.9)	12.4(62.4)	24.2(45.4)
Healthy	91.5(11.6)	268.4(34.4)	-13.8(2.4)	-43.3(18.7)	-4.5(1.9)
P value	<0.01	<0.01	<0.01	<0.01	<0.01

VL

Group	Heel Rock	Heel Rise	Step Up	Step Down	Drop Landing
PFPS	333.1(85.8)	347.4(182.8)	-124.7(248.6)	-141.6(250.6)	-106.1(140.9)
Healthy	304.2(8.2)	389.0(17.1)	-25.1(10.7)	46.6(14.9)	-21.4(12.4)
P value	0.047	0.016	<0.01	<0.01	0.016

Unit: mesc; (SD)

GM

Group	Heel Rock	Heel Rise	Step Up	Step Down	Drop Landing
PFPS	216.1(336.9)	260.9(380.0)	-8.2(179.3)	-48.2(169.8)	24.2(45.4)
Healthy	-333.1(4.7)	-352.6(4.8)	-190.2(5.8)	-139.8(4.3)	-255.1(10.0)
P value	<0.01	<0.01	<0.01	<0.01	<0.01

Unit: mesc; (SD)

Table 1: Temporal parameters (msec, mean (standard deviation)) of onset activation in vasti and gluteus medius muscles between PFPS and healthy controls.

VMO

PFJM	Heel Rock	Heel Rise	Step Up	Step Down	Drop Landing
Pre-I	319.0(8.8)	363.5(22.9)	-38.9(11.7)	-1.7(15.1)	-25.9(13.2)
Post-I	250.2(0.2)	372.6(13.0)	-62.4(5.7)	-62.4(5.7)	-52.1(14.9)
P value	<0.01	<0.01	<0.01	<0.01	<0.01

VMO-VL

PFJM	Heel Rock	Heel Rise	Step Up	Step Down	Drop Landing
Pre-I	91.5(11.6)	268.4(34.4)	-13.8(2.4)	-43.3(18.7)	-4.5(1.9)
Post-I	88.0 (6.6)	51.5(6.9)	-35.1(4.5)	-6.0(1.9)	-43.3(9.8)
P value	0.16	<0.01	<0.01	<0.01	<0.01

VL

PFM	Heel Rock	Heel Rise	Step Up	Step Down	Drop Landing
Pre-I	304.2(8.2)	389.0(17.1)	-25.1(10.7)	46.6(14.9)	-21.4(12.4)
Post-I	323.8(8.0)	392.8(7.9)	-25.1(10.7)	-62.5(4.7)	-43.3(9.8)
P value	<0.01	0.17	0.29	<0.01	<0.01

Unit: mesc; (SD)

GM

PFM	Heel Rock	Heel Rise	Step Up	Step Down	Drop Landing
Pre-I	-333.1(4.7)	-352.6(4.8)	-190.2(5.8)	-139.8(4.3)	-255.1(10.0)
Post-I	-456.1(133.2)	-497.2(161.5)	-187.5(12.1)	-16.1(5.0)	-20.7 (4.4)
P value	<0.01	<0.01	<0.01	<0.01	<0.01

Unit: mesc; (SD)

Table 2: Temporal parameters (msec, mean (standard deviation)) of onset activation of difference in vasti muscles and gluteus medius in healthy controls before and after patellofemoral joint mobilization. PFJM: Patellofemoral Joint Mobilization; Pre-I: pre-intervention; Post-I: post-intervention

DISCUSSION: In this study, there are significant delayed activations of vasti and gluteus muscles in people with PFPS during dynamic activities compared to healthy age- and BMI-matched controls. The findings are consistent with previous literature (Cowan et al, 2009; Braton et al 2013). Recently, there is a grwoing evidence to support the association of deficits in hip abductors (i.e. gluteus medius) with people with PFPS. We found that significant altered motor coordination of gluteus medius and vasti muscles appeared in people with PFPS. Barton et al (2013) proposed that delayed and shorter duration of gluteus medius may alter appropriate control the hip motion frontally and transversly. In physical therapy persepctives, joint mobilization intervention may reduce pain and improve muscle spasm and incrase joint range of motion. After patellofemoral joint mobilization, we found reduced delayed activation of vasti and gluteus medius muscles in people without and with PFPS. Bialosky et al (2009) proposed joint mobilization may provide a meidating spinal cord effect on neuromuscular response, such as afferent discharge, muscle activitiy and motorneuron pool. This proposed model may explain a possible mechanism of action of patellofemoral joint mobilization on people without and with patellofemoral pain syndrome. The limitations of this study are the criteria for experimental partcipation are individuals with unilateral PFPS, with history more than 3 months. Further studies are warrant to investigate the effects of patellofemoral joint mobilization on people in patellofemoral pain syndrome in the long term period.

CONCLUSION: We found that significant immediate altered motor coordination of these muscles appeared in people with and without PFPS after patellofemoral joint mobilization, especially for VMO. More importantly, It implies that this delayed motor coordination of knee and hip muscles may contribute to symptoms and dysfunctions in people with PFPS during functional activities.

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