**Article Full Title**

Lumbopelvic Joint Manipulation and Quadriceps Activation of People With Patellofemoral Pain Syndrome

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**Paper Abstract**

Context: Quadriceps weakness and inhibition are impairments associated with patellofemoral pain syndrome (PFPS). Lumbopelvic joint manipulation has been shown to improve quadriceps force output and inhibition, but the duration of the effect is unknown. Objective: To determine whether quadriceps strength and activation are increased and maintained for 1 hour after high-grade or low-grade joint mobilization or manipulation applied at the lumbopelvic region in people with PFPS. Design: Randomized controlled clinical trial. Setting: University laboratory. Patients or other participants: Forty-eight people with PFPS (age = 24.6 ± 8.9 years, height = 174.3 ± 11.2 cm, mass = 78.4 ± 16.8 kg) participated. Intervention(s): Participants were randomized to 1 of 3 groups: lumbopelvic joint manipulation (grade V), side-lying lumbar midrange flexion and extension passive range of motion (grade II) for 1 minute, or prone extension on the elbows for 3 minutes. Main outcome measure(s): Quadriceps force and activation were measured using the burst superimposition technique during a seated isometric knee extension task. A 2-way repeated-measures analysis of variance was performed to compare changes in quadriceps force and activation among groups over time (before intervention and at 0, 20, 40, and 60 minutes after intervention). Results: We found no differences in quadriceps force output (F(5.33,101.18) = 0.65, P = .67) or central activation ratio (F(4.84,92.03) = 0.38, P = .86) values among groups after intervention. When groups were pooled, we found differences across time for quadriceps force (F(2.66,101.18) = 5.03, P = .004) and activation (F(2.42,92.03) = 3.85, P = .02). Quadriceps force was not different at 0 minutes after intervention (t(40) = 1.68, P = .10), but it decreased at 20 (t(40) = 2.16, P = .04), 40 (t(40) = 2.87, P = .01) and 60 (t(40) = 3.04, P = .004) minutes after intervention. All groups demonstrated decreased quadriceps activation at 0 minutes after intervention (t(40) = 4.17, P < .001), but subsequent measures were not different from preintervention levels (t(40) range, 1.53-1.83, P > .09). Conclusions: Interventions directed at the lumbopelvic region did not have immediate effects on quadriceps force output or activation. Muscle fatigue might have contributed to decreased force output and activation over 1 hour of testing.

**NIH Risk of Bias Tool**

Quality Assessment of Controlled Intervention Studies

**Was the study described as randomized, a randomized trial, a randomized clinical trial, or an RCT**

Yes

**Was the method of randomization adequate (i.e., use of randomly generated assignment)?**

Yes

**Was the treatment allocation concealed (so that assignments could not be predicted)?**

Cannot Determine, Not Reported, or Not Applicable

**Were study participants and providers blinded to treatment group assignment?**

No

**Were the people assessing the outcomes blinded to the participants' group assignments?**

Yes

**Were the groups similar at baseline on important characteristics that could affect outcomes (e.g., demographics, risk factors, co-morbid conditions)?**

Yes

**Was the overall drop-out rate from the study at endpoint 20% or lower of the number allocated to treatment?**

Yes

**Was the differential drop-out rate (between treatment groups) at endpoint 15 percentage points or lower?**

Yes

**Was there high adherence to the intervention protocols for each treatment group?**

Yes

**Were other interventions avoided or similar in the groups (e.g., similar background treatments)?**

No

**Were outcomes assessed using valid and reliable measures, implemented consistently across all study participants?**

Yes

**Did the authors report that the sample size was sufficiently large to be able to detect a difference in the main outcome between groups with at least 80% power?**

Yes

**Were outcomes reported or subgroups analyzed prespecified (i.e., identified before analyses were conducted)?**

Cannot Determine, Not Reported, or Not Applicable

**Were all randomized participants analyzed in the group to which they were originally assigned, i.e., did they use an intention-to-treat analysis?**

Yes

**Key Finding #1**

Overall, interventions applied to the lumbopelvic region in this study did not immediately affect quadriceps force output or activation.

**Key Finding #2**

Quadriceps force output did not change at 0 minutes postintervention but decreased at both 20 minutes and 60 minutes postintervention, potentially due to local muscle fatigue experienced over the 1-hour testing session.

**Key Finding #3**

This study could not differentiate between the effects of intervention and running because there was no control used to determine the effects of running on quadriceps force output and activation.

**Key Finding #4**

The participants that withdrew from the study (7/48) experienced discomfort, apprehension, or anxiety with burst superimposition testing. Most of the participants that withdrew from the study (6/7) were female and had activation levels > 0.90.

**Please provide your summary of the paper**

This randomized control clinical trial aimed to determine whether quadriceps strength and activation are increased and maintained for 1 hour after high-grade or low-grade joint mobilization or manipulation applied at the lumbopelvic region in people with patellofemoral pain syndrome (PFPS). The participants were not actively seeking medical care for PFPS but did reveal deficits in quadriceps activation and self-reported function utilizing the Lower Extremity Functional Scale (LEFS). For this study, PFPS was classified as self-reported insidious onset of unilateral or bilateral pain that could be reproduced with at least 2 of the following: patellar compression, squatting, prolonged sitting, walking up or down stairs, or isometric quadriceps contraction. There were 48 participants (age =24.6 ± 8.9 years) with PFPS that were randomized into 1 of 3 groups: grade V lumbopelvic joint manipulation, grade II side-lying lumbar midrange flexion and extension passive range of motion for 1 minute, or prone extension on the elbows for 3 minutes. Quadriceps force and percentage of quadriceps activation were measured using burst superimposition technique during a seated isometric knee extension task. Changes between quadriceps force and activation among groups over time (before intervention, 0, 20, 40, and 60 minutes after intervention) were analyzed with a 2-way repeated-measures analysis of variance. The examiner obtaining measures was blinded to treatment group allocation. Of the 48 participants, 7 of them withdrew (6 women, 1 man), and their data was not used in the final statistical analysis. The findings revealed that interventions applied at the lumbopelvic region did not have an immediate effect on quadriceps force output or percent activation. Due to 1-hour testing session, it is possible that local muscle fatigue might have resulted in decreased force output and activation.

**Please provide your clinical interpretation of this paper. Include how this study may impact clinical practice and how the results can be implemented.**

Prior to this study being completed, there was no evidence about the duration of increased quadriceps strength or activation after lumbopelvic joint manipulation in a symptomatic population. Evidence was also lacking when comparing joint manipulation to lower-grade mobilizations on neurophysiologic effects in individuals with PFPS. The findings in this study revealed that interventions applied at the lumbopelvic region did not have an immediate effect on quadriceps force output or percent activation. However, joint manipulation may address specific impairments associated with PFPS such as decreased quadriceps activation and asymmetries in hip rotation. When considering clinical practice, this reveals that joint manipulation could be a component of a comprehensive rehabilitation program for an individual with PFPS as opposed to a primary treatment method. There were 7 participants (of 48) that withdrew from the study due to discomfort with burst superimposition testing. Future research implications could include examining changes in pain or discomfort in individuals with PFPS when lumbopelvic interventions were applied. Further research could also be done in order to determine the effect of running on muscular fatigue prior to performing measures of quadriceps force output and activation as this could have altered the results found in the study.