Changes in Lower Limb Strength and Function Following Lumbar Spinal Mobilization

Tsoi Sze Yuen, BS (Hons) Physiotherapy,[a] Pui Yu Lam, BS (Hons) Physiotherapy,[a] Mei Yan Lau, BS (Hons) Physiotherapy,[a] Wai Lam Siu, BS (Hons) Physiotherapy,[a] Ka Man Yu, BS (Hons) Physiotherapy,[a] Chi Ngai Lo, MMuscSportsPhyty,[b] and Joseph Ng, PhD[a]

Abstract

Objective: The purpose of this study was to investigate whether grade III passive lumbar rotational mobilization on L2-3 can improve hip flexor strength and performance in the single-leg triple-hop test in asymptomatic young adults.
Methods: Twenty-four participants (12 men, 12 women) aged from 19 to 26 years who were positive in the hip flexor "break" test were recruited in this study. They were randomly allocated to the treatment group or sham group. Isometric hip flexor torque (N·m) and single-leg triple-hop distance (cm) were measured before and after a passive lumbar rotational mobilization or a sham intervention.
Results: After the intervention, both the treatment and sham groups exhibited a significant increase in longest hop distance (P = .040 and .044, respectively). The treatment group had a significantly higher (3.41 ± 5.44%) positive percentage change in torque than the sham group (–2.36 ± 5.81%) (P = .02).
Conclusion: The study results indicated a potential effect of grade III passive lumbar rotational mobilization in improving hip flexor strength. However, whether the improvement in hopping performance was the result of a treatment effect or a learning effect could not be determined. (J Manipulative Physiol Ther 2017;40:587-596)
Key Indexing Terms: *Lumbar Spine; Musculoskeletal Manipulations; Muscle Strength*

Introduction

Muscle inhibition is defined as the inability to recruit motor units of a muscle normally during maximal voluntary contraction.[1] Muscle contraction signals start from the cerebral cortex, descend along the spinal cord to the peripheral motor nerve, and finally reach the targeted muscle. A malfunction in the conduction of the signals at any particular level would result in muscle inhibition. Injury and pain,[2,3] disturbance to afferent neural pathways,[4,5] and ineffective spinal or peripheral joint mechanics[6,7] are possible causes. Spinal mobilization and manipulation, which are the components of manual techniques, may relieve pain, facilitate sensory input, and restore joint mobility in the spine.[8,9] Passive spinal mobilization is defined as a low-velocity, non-thrust oscillation applied to the vertebrae, whereas spinal manipulation is a high-velocity, small-amplitude thrust motion applied at the end range of a physiological or accessory movement.[8] Given the possible impairments of the spine that can affect motor functions, several authors have investigated the effects of spinal mobilization on muscle inhibition.[2,4,5,10-14]

Early studies, which recruited patients with pain symptoms, reported that manual therapy of the spine seemed to reduce muscle inhibition and increase the strength of peripheral muscles, including the quadriceps,[12] biceps brachii,[13] shoulder external rotator,[5] and deep neck flexor.[2] With the advent of muscle inhibition studies, the focus shifted from symptomatic to asymptomatic participants. Strength gains were also recorded in the hip flexors,[4] quadriceps,[11,14] and lower trapezius[4,10] of asymptomatic subjects after spinal mobilization or manipulation. Unfortunately, there is no corresponding evaluation of whether the strength gains obtained after spinal mobilization are reflected in functional outcomes.

The hip flexor acts as the femoral head stabilizer[15] for effective lower limb movement in the functional position, and the iliopsoas muscle is the only muscle capable of flexing the hip at the end range of motion. Based on the result from previous studies that spinal mobilization can immediately improve lower limb muscle strength,[12,14] the

[a] Department of Rehabilitation Sciences, Hong Kong Polytechnic University, Hong Kong.
[b] Cluster of Health & Social Sciences, Singapore Institute of Technology, Singapore.
Corresponding author: Chi Ngai Lo, MMuscSportsPhyty, Rm 2401, Hin Kwai House, Hin Keng Estate, Shatin, Hong Kong. Tel.: +65 9234 2459. (e-mail: *lochingai@gmail.com*).
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change in strength should be able to be reflected in functional performance. Hence, this study aimed to investigate whether grade III passive lumbar rotational mobilization on L2-3 can improve hip flexor strength and performance in the single-leg triple-hop test (SLTHT). Although several possible causes of muscle inhibition were suggested, there was a specific focus on the neural pathway. Therefore, asymptomatic young adults were recruited for this study to minimize the influence of pain and mechanics on the spine.[2-7]

Methods

This study adopted a pre-test/post-test sham group design. Ethical approval was obtained from the Departmental Research Committee of the Hong Kong Polytechnic University. The clinical trial registration number is NCT02523508. Subject inclusion criteria were as follows: ages 18–29 years, presence of hip flexor weakness on either side or both sides, no active back or lower limb conditions, and no contraindications to spinal mobilization. Active conditions were defined as pain, injury, or other condition(s) diagnosed by a doctor or treated within the past 4 weeks. Contraindications included any pathology leading to significant bone weakening such as tumors, osteoporosis, fracture, rheumatoid arthritis, pregnancy, and spinal dysfunctions.[8] Participants not fulfilling the inclusion criteria were excluded. Twenty-four participants (12 men and 12 women) were recruited from the university using the convenience sampling method. Sample size was determined by calculations described by Cohen.[16] Given a 2-tailed hypothesis, the level of significance set at .05 and the power at 0.8, because the data from the pilot study[14] were available to produce a large effect size. The number of subjects in this study was considered an adequate sample size. The subjects were a combination of junior (years 1 and 2) students from different disciplines including physiotherapy, occupational therapy, accounting, and engineering. Written consent was collected prior to participation.

An equal number of letters 'A' and 'B,' representing the treatment group and sham group, respectively, were placed in a sealed envelope. To blind the assessors and the participants, only the operator who conducted the intervention knew the allocations throughout the data collection process. Participants drew from the envelope and passed the letter to the operator without seeing it, and the intervention was delivered accordingly.

Instrumentation

A calibrated hand-held dynamometer, the Nicholas Manual Muscle Tester, Model 01160 (Lafayette Instrument, Lafayette, Indiana), was used to measure maximal voluntary isometric hip flexor strength. Assessment of hip flexor isometric strength in the supine position in healthy young adults using a hand-held dynamometer exhibited excellent test-retest reliability, with intraclass correlation coefficients in the range 0.93–0.94.[17]

A 1.5-m-long tape was used to measure the hop distance on an 8-m-long path with markings at every 1 m. SLTHT exhibited good test–retest reliability, with an intraclass correlation coefficient of 0.88.[18] Hopping requires dynamic stability, which can be quantified by measuring the center of pressure and ground reaction force using a force plate.[19] Although no study has proven a direct correlation with hip strength, the correlation of the triple-hop test with quadriceps and hamstring strength was found to be 0.49–0.59.[20] In addition, SLTHT includes propulsion and landing phases in which the muscles in the entire lower limb must activate in a timely and adequate manner. High neuromuscular demands are expected on the lower limb to reach the maximum distance performance.[21] Thus, SLTHT is commonly adopted as a functional test to access lower limb strength and stability.

Screening

Contraindications were screened, and all participants were deemed fit to join the study. The hip flexor "break" test, an isometric holding test, was performed as the screening test using standardized procedures. While the participant maintained the supine position with the hip in 90° flexion, the assessor applied pressure against his or her resistance. The assessor resisted at the starting position for 1 to 2 seconds to allow the participant to build up maximal strength until the participant could no longer increase force, then gradually overcame the hip flexor force with slight additional pressure and stopped when the participant gave way within 4 seconds.[22-24] A positive result was defined as the participant having non-fatigable weakness, that is, a rapid decrease in resisting force within 4 seconds, or a "giving way." A negative result refers to the ability to adapt to the additional force and sustain strength.[5,23] Intra-agreement and inter-agreement for the test were 0.67 and 0.83, respectively.[25,26] Qualified participants with positive results on 1 or both sides were randomly allocated to the treatment group or the sham group.

Baseline Measurement

The base of the patella on both sides was marked to measure leg length, which was the distance from the superior border of the patella to the hip joint line. The marks also indicated the placement of the dynamometer (Fig 1). Baseline hip flexor strength was measured twice using the same procedures as in the screening test. The first assessor, who was blinded to the intervention group and the inhibited side of the participants, performed the strength measurement in an isolated room. The dynamometer was placed