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Original Article

Effects of trajectory exercise using a laser pointer on electromyographic activities of the gluteus maximus and erector spinae during bridging exercises

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Abstract. [Purpose] The purpose of this study was to investigate activities of the hip extensors and erector spinae during bridging exercise by using instruments with a laser pointer on the pelvic belt. [Subjects] Twelve subjects (age, 23 to 33 years) with non-specific low back pain volunteered for this study. [Methods] Subjects performed bridging exercises with and without trajectory exercises by using a laser pointer fixed to a pelvic strap. The erector spinae, gluteus maximus and hamstring activities with and without trajectory exercises using a laser pointer were recorded on using electromyography. [Results] Compared to the without laser pointer group, the group that underwent bridging with trajectory exercises using a laser pointer had significantly higher gluteus maximus activity and significantly lower erector spinae activity. Significantly higher gluteus maximus/erector spinae activity ratios were observed when performing trajectory exercises using a laser pointer during bridging exercises. [Conclusion] This result suggests that trajectory exercises using a laser pointer during a bridging exercise would be effective for improving gluteus maximus activity.

Key words: Gluteus maximus, Trajectory exercise, Bridging exercise

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INTRODUCTION

Previous studies focused on retraining muscle coordination patterns in which the optimal ratios between the gluteus maximus (GM) and the erector spinae (ES) are assumed to be essential[1–3)]. Bridging exercises are associated with a risk of dominant hamstring (HAM) and ES activities as compensation for GM weakness[3)]. Various studies have indicated that specific lumbar stabilizing exercises combined with other therapies can prevent unwanted movement error[1, 4)]. The practice of pointing or positioning tasks improves performance of trunk movement in persons with back pathologies[2)]. Rehabilitation professionals prescribe supine bridging to neutral spine exercises to target the GM[4–6)]. Thus, to prevent excessive movement of the lumbar and thoracic spine, therapists often ask patients to stabilize the spine via therapist hands or abdominal drawing-in maneuver (ADIM)[5)]. No previous studies have used visual biofeedback with a laser pointer on the pelvic belt for lumbar stabilization exercises as therapy for individuals with low back pain. To our knowledge, this study is the first to evaluate the effect of trajectory exercises using a laser pointer on GM muscle activity during a bridging exercise. We created an instrument that enabled trajectory exercises with a laser pointer on a pelvic strap to prevent unwanted movement of the lumbar spine. In addition, this instrument can aid repositioning accuracy of the trunk during selfbridging exercises. The purpose of this study was to investigate activities of the hip extensors and ES during bridging exercises by using a raiser pointer on the pelvic belt.

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SUBJECTS AND METHODS

Twelve non-specific subjects with low back pain (age, 23 to 33 years) volunteered for this study. The inclusion criteria were patients with non-specific low back pain for >3 months and the willingness and ability to participate in the task safely. The study purpose and methods were explained to all the subjects, who provided their informed consent according to the principles of the Declaration of Helsinki before participation. Subjects performed the same bridging exercise twice and maintained each position for 5-s under two conditions: using instruments a laser pointer (LPT) and without an LPT. Bridging exercise performed without ILP was followed by bridging exercises with LPT to minimize the carry over or learning effect[4]. The subjects were placed in the supine position. Both knees were flexed at 90°, the feet were placed hip-width apart while resting on the floor, and the toes were faced forward. The arms were crossed over the chest to minimize arm support. A universal goniometer was used for knee and hip angle measurements. Each subject was instructed to lift the pelvis comfortably at a self-selected speed while maintaining the trunk, pelvis, and thigh in a straight line and holding the bridging position for 5 s. Bridging with LPT followed the same procedure as bridging without LPT, with the exception of the application of laser pointer trajectory for visual biofeedback. A white board and laser pointer attached on the pelvic strap were prepared for visual biofeedback. The white board, which was 50 cm long and 70 cm wide, was attached to both Parallel bar. A vertical line of 30-cm length through the cranial direction was drawn in the center of the board. Further, the start and end markers of the vertical line were displayed in both ends. A plastic cylinder, 7.5 cm long and 2.5 cm in diameter, designed to focus a 0.5 cm diameter laser pointer was attached to a pelvic strap. Kinematic data from the hip and knee joints were acquired using video analysis system control. A strap with a laser attached for visual biofeedback was worn on each subject's lower back (positioned above the ASIS). Subjects performed bridging exercises while attempting to control the red ray from the laser-pointer such that it moved along the vertical line (length 30 cm) to the cranial direction until the end marker was drawn on the board. EMG data were collected using Biopac MP100WSW (Biopac Systems, Inc, Goleta, CA). For normalization, maximal voluntary isometric contraction (MVIC) was calculated for each muscle. Two surface electrodes with an interelectrode distance of 2 cm were positioned on the GM, medial HAM, and ES bilaterally. Trunk muscles (ES, GM, and HAM) activities with and without trajectory exercises using a laser pointer were analyzed using SPSS Statistics ver. 18.0 (Chicago, IL, USA). The significance between the two conditions was tested using paired t-tests, with significance at $p<0.05$.

RESULTS

Compared to the group with the laser pointer, the EMG signal amplitude was significantly higher for the GM in the group that performed bridging exercises with visual biofeedback using a laser pointer (28.6 ± 18.0% versus 21.3 ± 12.9%), and was significantly lower in the ES (26.8 ± 15.1% versus 43.1 ± 16.8%) ($p < 0.05$). However, there were no significant differences in the activities of the HAM between the groups with (53.3 ± 52.3%) and without (41.7 ± 32.3%) laser pointer use ($p > 0.05$). For bridging exercise with visual biofeedback using laser pointer, the GM/ES ratios were significantly higher in the group with laser pointer use than in the group without ($p<0.05$).

DISCUSSION

This study is the first to evaluate the effect of trajectory exercise using the laser beam on GM activity during bridging exercises. GM activity increased significantly during bridging with visual biofeedback using the laser pointer, supporting the research hypothesis. On the other hand, there was no significance difference in ES and HAM activities between groups. A possible explanation is that performing trajectory exercises with the laser beam during bridging exercises can prevent excessive anterior pelvic tilt. Weakness of the GM and dominant activity of the ES due to low back pain may contribute to excessive back spine hyperextension during bridging exercises[7]. Thus, moving a raiser pointer on the pelvic strap along the quantified cranial direction during bridging exercises could be a good strategy for CLBP when anterior pelvic tilt and lumbar lordosis motion are minimized. In terms of muscle ratios, GM/ES ratios were significantly higher when a laser pointer was used than when one was not used. Based on these studies, synergistic trunk extensors such as the GM and ES can affect one another during bridging, increasing GM activity and reducing ES activity. These results also suggest that using a raiser pointer during bridging exercise promotes activation of the hip extensors, while reducing activation of the ES. A previous study reported that isometric hip abduction facilitated GM activity in advance[8]. Previous evidence suggests that patients with chronic low back pain exhibit deficits in trunk proprioception and motor control[2, 7]. These deficits can affect and compromise segmental spinal stability and eventually lead to articular damage and subsequent chronic pain[2]. We consider that applying visual biofeedback using a laser pointer during bridging facilitated GM activity in advance before the initiation of the bridging movement, consequently increasing GM activity.

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