Effect of the Abdominal Hollowing and Bracing Maneuvers on Activity Pattern of the Lumbopelvic Muscles During Prone Hip Extension in Subjects With or Without Chronic Low Back Pain: A Preliminary Study

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Abstract

Objective: The purpose of this study was to compare the effect of abdominal hollowing (AH) and abdominal bracing (AB) maneuvers on the activity pattern of lumbopelvic muscles during prone hip extension (PHE) in participants with or without nonspecific chronic low back pain (CLBP).

Methods: Twenty women with or without CLBP participated in this cross-sectional observational study. The electromyographic activity (amplitude and onset time) of the contralateral erector spinae (CES), ipsilateral erector spinae (IES), gluteus maximus, and biceps femoris muscles was measured during PHE with and without abdominal maneuvers. A 3-way mixed model analysis of variance and post hoc tests were used for statistical analysis.

Results: Between-group comparisons showed that the CES onset delay during PHE alone was greater ($P = .03$) and the activity level of IES, CES, and biceps femoris in all maneuvers ($P < .05$) was higher in patients with CLBP than in asymptomatic participants. In asymptomatic participants, PHE + AH significantly decreased the signal amplitude (AMP) of IES ($P = .01$) and CES ($P = .02$) muscles. In participants with CLBP, IES muscle AMP was lower during PHE + AH compared with PHE + AB and PHE alone. With regard to onset delay, the results also showed no significant difference between maneuvers within either of the 2 groups ($P > .05$).

Conclusions: Performance of the AH maneuver decreased the erector spinae muscle AMP in both groups, and neither maneuver altered the onset delay of any of the muscles in either group. The low back pain group showed higher levels of activity in all muscles (not statistically significant in gluteus maximus during all maneuvers). The groups were similar according to the onset delay of any of the muscles during either maneuver. (J Manipulative Physiol Ther 2017;40:106-117)

Key Indexing Terms: *Chronic Low Back Pain; Diagnostic Test; Hip; Exercise Therapy; Pressure; Biofeedback; Abdominal Muscles; Paraspinal Muscles; Response Latency; Surface Electromyography*

Introduction

Low back pain (LBP) is among the most prevalent and costly health problems.[1] The prevalence of LBP is higher in women, and women are more likely to suffer from functional disability because of LBP.[2,3] Among the various factors associated with chronic low back pain (CLBP), attention has been drawn to the changes in motor control and trunk muscle function within the past decade. Muscle imbalance (not becoming active at the right moment with adequate intensity) of the lumbopelvic region may lead to LBP by imposing undue stress and compression on the vertebrae.[4,5] Reduced or delayed activity of the multifidus[6,7] and transversus abdominis (TrA)[8,9] and change from tonic to phasic activity of the TrA[10] are noticeable behaviors in people with LBP. A number of studies have shown higher levels of erector spinae (ES) activity during various tasks in patients with LBP compared with non-LBP subjects.[11-13] Different muscle recruitment strategies may be used to increase trunk stiffness (in terms of resistance to vertebral displacement[14]) and to enhance spinal stability in patients with lumbopelvic pain, possibly as a compensation to counteract impaired spine stability.[15,16]

A test commonly used for evaluation of the recruitment pattern[17] and stability of lumbopelvic muscles in CLBP (with or without leg pain)[18] is prone hip extension (PHE), a

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maneuver developed by Janda. The muscle activity pattern during this movement has been theorized to simulate those used during functional activities, such as gait.[19] It is thought that changes in this pattern can decrease the stability of the lumbopelvic region during walking, which could be a risk factor for the initiation or exacerbation of LBP.[20] The most common sign of a faulty recruitment pattern (although seriously challenged recently) has been proposed to be[18,21] alteration in the timing or activity level, or both, of the tested muscles. This test is also commonly used as a therapeutic exercise in patients with LBP to strengthen the trunk and hip extensors and stretch the hip flexors. Despite a lack of strong evidence, altered muscle recruitment pattern within the back and hip extensors during PHE has been proposed as a prevalent dysfunctional pattern[19,22] in patients with LBP, which possibly contributes to reduced lumbopelvic stability.[23] A recent study has attributed the higher activity in ES, gluteus maximus (GM), and biceps femoris (BF) to spinal instability[24] in patients with LBP compared with asymptomatic participants. Vogt et al. have proposed that alterations in the timing of trunk and hip extensors during walking decrease the stability of the lumbar spine and pelvis, which might lead to the development of low back pain.[20] Coordinated back and hip extensor activity have also been proposed to be crucial to the stability of the lumbopelvic region during PHE.[11,25]

Spinal stability (or *instability*) is a complex concept that is being approached from both mechanical (radiographic) and functional (clinical) points of view.[16,26] *Mechanical instability* is attributed to excessive spinal segmental movement and is confirmed by radiography.[26] *Functional instability* is defined as a failure in the maintenance of intervertebral neutral zones under loaded conditions, which results in pain and disability.[16] It has been hypothesized that increased muscular activity in patients with LBP may be required to compensate for reduced spinal stability,[27,28] which comes with the cost of increased spinal compression. Lumbar stabilization exercises have been recommended to improve motor control of the lumbopelvic region.[29] It is also hypothesized that unwanted increased lumbar global muscle activity may be prevented or decreased if adequate stability is provided.

The role of abdominal muscles (both deep and superficial) in the stabilization of the spine has been well established.[30] Abdominal hollowing (AH) and abdominal bracing (AB) maneuvers are commonly used to activate abdominal muscles to increase spinal stability. Abdominal hollowing is performed to activate the deep abdominal muscles—namely, TrA and the internal oblique abdominal muscle—while minimizing superficial global muscle activity[30] and thus seems effective in preserving the motor patterns of abdominal muscles and consequently enhancing spinal stability.[31,32]

Abdominal bracing focuses on activation of all abdominal wall muscles. According to McGill,[33] sufficient stability of the lumbar spine is achieved with modest levels of simultaneous activation in all trunk muscles. Recently, it has been suggested that AH is suitable for treatment of unstable spine with altered abdominal muscle recruitment pattern, whereas AB might be more suitable for use in healthy participants,[34] although this hypothesis needs further investigation to be applied clinically. Some previous studies reported alterations in electromyography (EMG) signal amplitude (AMP)[35,36] and timing[37] of the lumbopelvic muscles during hip extension and abduction in healthy participants when these movement were accompanied by AH. Performance of AH and AB maneuvers in asymptomatic participants have been reported to reduce EMG activity of lumbar ES muscles. The authors suggested that the effective stabilization provided by this maneuver reduced the need for increased global muscle activity.[38] It thus seems worthwhile to investigate the effects of clinically relevant and frequently used abdominal maneuvers on the recruitment pattern of lumbopelvic muscles (as a determining factor for spinal stability) during PHE. Despite the inherent discrepancies the 2 tasks have in terms of body posture and gravity influences, lumbopelvic muscle activity during PHE has been proposed to mimic muscle activity during gait.[37,39] To the best of our knowledge, no study has directly compared the effect of abdominal stabilizing maneuvers on the trunk muscular activation patterns (EMG AMP and onset time), which have been suggested to reflect motor control strategy, in participants with LBP.

Therefore, the objectives of this study were to[1] compare the activation pattern of the ipsilateral and contralateral ES (IES and CES, respectively), GM, and BF muscles during PHE between asymptomatic participants and patients with CLBP and[2] assess the effect of AH and AB maneuvers on the EMG signal AMP and timing of these muscles in both groups. On the basis of previous findings, we hypothesized that[1] the lumbopelvic muscle activity level during PHE is higher in patients with CLBP compared with asymptomatic participants,[2] performance of abdominal stabilizing maneuvers will reduce EMG activity level and onset time delay in lumbopelvic muscles during PHE, and[3] the EMG AMP and onset delay are significantly lower in AH than in AB. Investigation of the differences between groups and maneuvers may provide beneficial information for clinicians who engage in exercise prescription for patients with CLBP and those susceptible to low back dysfunction.

Methods

Study Design

This study has a mixed factorial design: 2 (groups: healthy participants and patients) × 4 (muscles: IES, CES, GM, BF) × 3 (maneuvers: PHE, PHE with AH, PHE with AB).

Participants

Study participants comprised 10 women with nonspecific CLBP with a mean (standard deviation) age of 33.6