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Lumbopelvic motor control function between patients with chronic low back pain and healthy controls: a useful distinguishing tool

The STROBE study

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Abstract

Although lumbopelvic stability exercise improves lumbopelvic motor control function in patients with chronic low back pain (CLBP), the difference in lumbopelvic motor control function between the patients with CLBP and the healthy controls is unclear. The purpose of this study was to compare lumbopelvic motor control function between patients with CLBP and healthy controls and to determine the prevalence of CLBP according to core stability function.

For this study, 278 participants were recruited, including patients with CLBP (n = 137) and healthy controls (n = 141). The participants performed a core stability function test and were classified to either the low or high core stability function group according to their core stability function for CLBP prevalence analysis.

Lumbopelvic motor control was significantly higher in the healthy controls than in patients with CLBP. Of the patients in the low lumbopelvic motor control function group, 65.9% had CLBP, whereas 36.8% of the patients in the high lumbopelvic motor control function group had CLBP. Lumbopelvic motor control function demonstrated a significant difference between the patients with CLBP and the healthy controls. The lumbopelvic motor control function test was demonstrated to be an effective diagnostic tool for distinguishing CLBP. This information can be applied in assessments and interventions for CLBP in clinical settings.

Abbreviations: CLBP = chronic low back pain, LBP = low back pain, PBU = pressure biofeedback unit, VAS = visual analog scale.

Keywords: chronic low back pain, lumbopelvic stability, motor control function, prevalence

1. Introduction

Lower back pain (LBP) is one of the most prevalent health care problems,[1,2] and chronic LBP (CLBP) is defined as persistent LBP for at least 3 months, which accounts for 23% of LBP cases.[3] LBP affects the motor control of the trunk muscles that regulate spinal movements and lumbopelvic stability.[4,5] Lumbopelvic stability is the ability to maintain a stable lumbopelvic position during limb movements.[5,6] Lumbopelvic stability is commonly assessed by the ability to control the lumbar curve during leg lowering in various measurement methods,[7] and a recent study suggested a method of evaluating the ratio scale using hip flexion angles.[8,9] Muscles that maintain lumbopelvic stability are local muscles of postural, tonic, and segmental stabilizers, such as the lumbar multifidus, pelvic floor, transversus abdominis, and diaphragm.[10,11] In addition, global muscles of dynamic, phasic, and torque-producing capabilities, such as the rectus abdominis and external oblique, contribute to lumbopelvic stability.[10] Decreased lumbopelvic stability causes faulty movement of the spine during limb movement, and the faulty movement may cause mechanical irritation to the adjacent joint.[7] Repeated and accumulated faulty movement can cause LBP. Therefore, in patient management for CLBP, lumbopelvic stability exercise is important.[5,6]

Many clinical studies have investigated the efficacy of lumbopelvic stability exercise in reducing the associated pain, disability,[12] and activity limitation in patients with CLBP[13] and further episodes of LBP.[14] Mannion et al[12] reported that lumbopelvic stability exercise for 9 weeks increased physical ability and decreased pain intensity. Hides et al[14] reported that lumbopelvic stability exercise decreased the likelihood of further episodes of back pain by 12.4 times. A previous systematic review[15] demonstrated that lumbopelvic stability training can induce neuromuscular changes and potential injury preventive effects in female athletes.

Lumbopelvic stability exercise improves the lumbopelvic motor control function in patients with CLBP because these

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The datasets generated during and/or analyzed during the current study are publicly available.

The authors have no conflicts of interest.

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patients have decreased lumbopelvic motor control function, such as deep abdominal muscle contraction,[12,13] delayed electromyography onset,[16,17] and thickness of the transverse abdominis,[18,19] compared with individuals without CLBP. However, the difference in lumbopelvic motor control function between individuals with and without CLBP remains unclear. In addition, the prevalence of CLBP according to lumbopelvic motor control function is unclear. Clarifying the lumbopelvic motor control function of patients with CLBP will help provide these patients with specific and precise interventions. Therefore, the aims of this study were to compare lumbopelvic motor control function (1) between patients with and without CLBP and (2) between men and women and (3) to determine the prevalence of CLBP according to lumbopelvic motor control function.

2. Materials and methods

2.1. Participants

The participants were recruited from local communities and universities. The inclusion criteria for patients with CLBP were as follows: (1) age between 18 and 60 years, (2) visual analog scale (VAS) scale score ≥5 for the assessment of pain intensity, (3) LBP persisting for >3 months, and (4) ability to perform the lumbopelvic motor control function test. The inclusion criteria for healthy controls were as follows: (1) have been LBP-free for at least the past year and (2) no history of LBP requiring a visit to the hospital or time off work. The exclusion criteria were spinal canal stenosis, spondylolisthesis, spondylitis, large herniated disc sciatica, radiating pain below the knee, previous back surgery, history of known spinal fractures, malignancy, known muscle, nerve, skin, or joint diseases, and pregnancy.[20] G * power ver. 3.1.2 (Franz Faul, University of Kiel, Kiel, Germany) was used for the power analysis. A power of 95% and level of 0.05 were assumed, and the effect size ($d=0.44$) was calculated using the mean and standard deviation of the lumbopelvic motor control stability function in each group. As a result of the power analysis, at least 112 participants in each group were required. Of the 336 participants recruited initially, 278 met the inclusion criteria. The healthy controls were matched for demographic characteristics with the patients with CLBP. Written informed consent was obtained from all participants. This study was approved by the Yonsei University Wonju Institutional Review Board (1041849-201802-BM-013-01).

2.2. Measurement and instruments

Lumbopelvic motor control function was assessed using the lumbopelvic stability test described by Jung et al[8]; it has a high intra-rater reliability. To measure lumbopelvic motor control function, the participants flexed their hip and knee to 90° in the supine position (Fig. 1A). Ipsilateral hip and knee extensions were performed to maintain abdominal pressure without the leg or foot touching a supporting surface (Fig. 1B). Abdominal pressure was measured with a pressure biofeedback unit (PBU; Stabilizer, Chattanooga Group Inc., Hixson, TN). The PBU was set to 40 mm Hg and was placed below the lordotic curve of the spine between S1 and L1, with the hip and knee in 90° flexion. Then, the pressure of the PBU was increased by 10 mm Hg, while the abdominal drawing-in maneuver was performed by the participants. The range of motion of hip extension was defined as the lumbopelvic motor control function and measured on both sides when the pressure decreased to <50 mm Hg during hip extension. The range of motion of hip extension while the lumbopelvis was stable was measured using a Smart KEMA motion sensor (KOREATECH Co, Ltd, Seoul, Korea). The participants were instructed to perform the lumbopelvic motor control function test and familiarize themselves with the test for 3 minutes. The lumbopelvic motor control function test was performed for 5 seconds on each side with a 3-minute rest between tests.

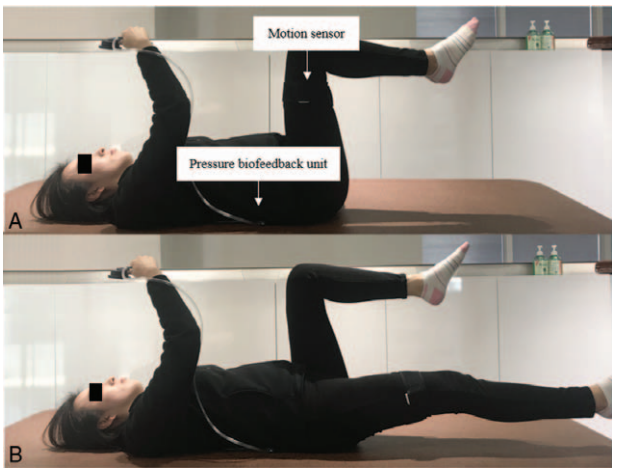

Figure 1. Measurement of lumbopelvic motor control function (A: initial position; B: performing position).

2.3. Data processing and statistical analysis

Statistical analyses were performed using the SPSS software (ver. 24.0; SPSS, Inc., Chicago, IL). The Kolmogorov–Smirnov Z test was used to confirm the normality of data distribution. As normal distribution of the variables was confirmed, an independent t test was used to compare the lumbopelvic motor control function between the control and pain groups. All analyses were performed using the mean values of measurements. The prevalence of CLBP was determined by classifying lumbopelvic motor control function as low and high based on the whole data of control and pain groups combined. The mean (±standard deviation) lumbopelvic motor control function (range of motion of hip extension) of 278 subjects was 48.72°±25.01°. The mean and standard deviation values were used to define a high lumbopelvic motor control function group if lumbopelvic motor control function was larger than the sum of the 2 values (>73.73°) and a low lumbopelvic motor control function group if lumbopelvic motor control function was smaller than the difference of the 2 values (<23.71°). A Chi-square test was performed to identify statistically significant differences between the low and high lumbopelvic motor control function groups. A P value of <.05 was considered indicative of statistical significance.

3. Results

3.1. Description of the study sample

In total, 278 participants were enrolled in the study, including 141 healthy controls (50 men and 91 women) and 137 patients with CLBP (51 men and 86 women). No significant difference was observed in sex ($\chi^2=.094$, $P=.76$), age ($t=-1.404$, $P=.161$), height ($t=-.037$, $P=.097$), or body mass ($t=-.231$, $P=.818$) between the groups. The pain group had a mean VAS score of 6.44 (Table 1).

Table 1

Summary of the subjects' demographics and the bivariate relationship of the groups with selected demographics.

Variable	Healthy controls	Patients with chronic lower-back pain	Statistic	*P*
Number of subjects	141	137		
Sex				
Female	91	86	$\chi^2=0.094$	.760
Male	50	51		
Age, y				
Range	21–54	23–52	$t=-1.404$	.161
Mean ± SD	32.35 ± 5.74	33.42 ± 6.99		
Height, cm				
Range	153–187	153–184	$t=-0.037$	.970
Mean ± SD	166.95 ± 8.06	166.99 ± 7.92		
Body mass, kg				
Range	46–98	40–96	$t=-0.231$	.818
Mean ± SD	63.88 ± 12.02	64.23 ± 14.21		
Pain on VAS, mm				
Range	0	5–9		
Mean ± SD	0	6.44 ± 1.15		

VAS = visual analog scale.

3.2. Comparison of lumbopelvic motor control function between participants with and without CLBP

The results of the comparison of lumbopelvic motor control function between the patients with CLBP and the healthy controls are demonstrated in Table 2. The healthy controls demonstrated significantly increased lumbopelvic motor control function (53.96° ± 24.20°) compared with the patients with CLBP (43.33° ± 24.76°) ($t=3.621$, $P<.001$). Among the men, the healthy controls demonstrated significantly increased lumbopelvic motor control function (60.70° ± 20.77°) compared with the patients with CLBP (50.86° ± 23.66°) ($t=2.221$, $P=.029$). In addition, among the women, the control group demonstrated a significantly increased lumbopelvic motor control function (50.25° ± 25.25°) compared with the patients with CLBP (38.86° ± 24.43°) ($t=3.048$, $P=.003$).

Table 2

The hip extension angles for measuring core stability.

	Healthy control, °	Patient with chronic low back pain, °	*t*	*P*
Total	53.96 ± 24.20	43.33 ± 24.76	3.621	<.000
Men	60.70 ± 20.77	50.86 ± 23.66	2.221	.029
Women	50.25 ± 25.25	38.86 ± 24.43	3.048	.003

3.3. Identification of CLBP according to lumbopelvic motor control function

Figure 2 displays the lumbopelvic motor control function as a histogram. In the low lumbopelvic motor control function group, 41 (69.4%) of 59 participants had CLBP compared with 20 (33.9%) of 59 participants in the high lumbopelvic motor control function group ($\chi^2=14.966$, $P<.001$).

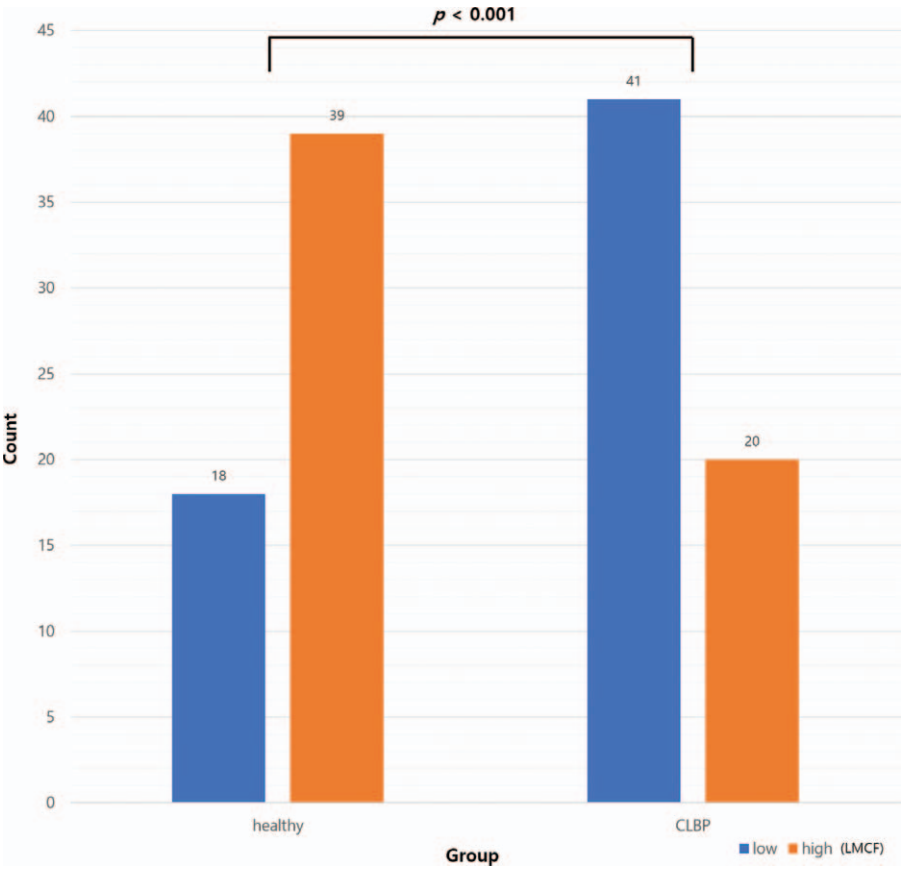

Figure 2. Chi-square cluster graph of lumbopelvic motor control function. CLBP = chronic low back pain; LMCF = lumbopelvic motor control function.

4. Discussion

In this study, patients with CLBP had decreased lumbopelvic motor control function and those with low lumbopelvic motor control function had an increased prevalence of CLBP. In previous studies that compared participants with and without CLBP, those with CLBP had decreased abdominal muscle strength[21–23] and deep abdominal muscle thickness during rest and contraction.[18,19,24,25] Regarding electromyography onset of the transversus abdominis in participants with LBP during lower limb movement, only few studies have compared the lumbopelvic motor control function between participants with and without CLBP.[26]

Pulkovski et al[27] studied a diagnostic tool that distinguishes between individuals with and without CLBP using transverse abdominis contraction ratio and concluded that the method does not distinguish well between participants with and without CLBP.[27] The present study included patients CLBP with a pain score on a VAS scale of ≥5 to accurately distinguish these patients from healthy controls. A statistically significant difference was observed between the patients with CLBP and the healthy controls. Therefore, the lumbopelvic motor control function test can be a useful diagnostic tool to distinguish between individuals with and without CLBP. The method is time saving, convenient, and inexpensive; thus, it is accessible and effective for routine clinical evaluations to distinguish between individuals with and without CLBP.

Previous studies used methods of assessing lumbopelvic stability according to the success of leg lowering. The leg lowering test by Rose et al[28] assesses lumbopelvic stability with a pressure cuff under the lumbar curve in a hook lying posture for screening loss of lumbopelvic stability while lowering the leg and maintaining lumbar curve. The lower abdominal muscle performance test by Sahrmann[7] is scored (9 grades) according to the ability to control lumbar curve during leg lowering. However, it is difficult to accurately quantify the value of lumbopelvic stability because these methods evaluate the lumbopelvic stability using an ordinal scale of whether the test was successfully performed. Therefore, this study measured the hip extension angle while maintaining lumbopelvic during leg lowering by using the method of Jung et al,[8] which was a modification of the method by Sahrmann[7] method. This method was advantageous in this comparison study because it accurately quantifies the value of lumbopelvic stability measuring the ratio using the hip extension angle instead of the success of the test performed.

Although not in a large-scale study, Nadler et al[29] reported no significant advantage of lumbopelvic stability exercise in reducing LBP occurrence on collegiate athletes. In this study, the high lumbopelvic motor control function group had a lower prevalence of CLBP than the low lumbopelvic motor control function group. These results indicated that individuals with low lumbopelvic motor control functions are more likely to have CLBP. However, this does not mean that the prevalence of CLBP or the pain itself is reduced by applying an intervention that only increases lumbopelvic stability in patients with CLBP as mentioned in previous studies.[2,5,12] CLBP can be caused by various factors, among which one is lumbopelvic stability. Therefore, patients with CLBP should receive an intervention specific for the decreased ability in CLBP based on accurate measurements of ability such as lumbopelvic stability, muscle strength, or the passive system such as passive range of motion.

The current study had several limitations. The lumbopelvic stability of CLBP was 43.33°±24.76° in this study. The lumbopelvic stability of CLBP with lumbar flexion syndrome was 46.30°±24.41° in the study by Jung et al.[8] Our study recruited patients with CLBP without subgrouping and would have included patients with CLBP and lumbar extension and rotation syndrome. These factors may have produced a difference in lumbopelvic motor control function compared with those in previous studies, which is the first limitation of the present study. In further studies, lumbopelvic motor control function will be identified by subgrouping. The second limitation is that this was a cross-sectional study. In further studies, to determine whether lumbopelvic motor control function affects decreased CLBP, we will study the effect of lumbopelvic stability exercise on CLBP in patients with low lumbopelvic motor control function.

5. Conclusion

This study compared lumbopelvic motor control function between patients with CLBP and healthy controls and investigated the prevalence of CLBP according to core stability function. The results of this study found that patients with CLBP had decreased lumbopelvic motor control function, and those with low lumbopelvic motor control function had an increased prevalence of CLBP. The results of this study can be a guide for appropriate assessments and interventions for CLBP in clinical settings.

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