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Effects of a Trunk Harness on Lumbopelvic Stability and Muscle Activity during Prone Hip Extension Exercise

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Abstract

Background: Therapeutic exercise is essential in patients with low back pain and lumbopelvic instability. Intra-abdominal pressure is necessary for ideal dynamic stabilization patterns. However, accurate performance of such exercises is a challenge. A trunk harness can help stabilize and alter muscular patterns. This study aimed to examine the effects of using a trunk harness on lumbopelvic stability and muscle activity during prone hip extension in healthy individuals and patients with low back pain. **Methods:** Sixteen patients with low back pain and 15 healthy individuals performed prone hip extension under control, Dynamic Neuromuscular Stabilization(DNS)-maneuver, and DNS-maneuver + harness conditions. Lumbopelvic kinematic data, muscle onset time of the bilateral erector spinae, semitendinosus, gluteus maximus, low back pain severity, and difficulty performing prone hip extension were evaluated. Repeated-measures two-way analysis of variance was performed for each measurement item. The significant level was set at 5%. **Results:** The lumbar lordosis angle was significantly lower in the DNS-maneuver and DNS-maneuver + harness conditions. The anterior pelvic tilt angle was significantly lower, and muscle onset of the gluteus maximus and contralateral erector spinae occurred earlier in the DNS-maneuver + harness condition. The difficulty of performing prone hip extension was significantly lower in the DNS-maneuver and DNS-maneuver + harness conditions and was considerably lower in the DNS-maneuver + harness condition than in the DNS-maneuver condition. **Conclusion:** Wearing a trunk harness could help stabilize the lumbopelvic region and change muscle activity patterns.

Keywords: prone hip extension, lumbopelvic stability, muscle activity onset time, trunk harness, low back pain

Introduction

Low back pain accounts for a high percentage of cases of chronic pain and is responsible for significant economic losses worldwide; thus, the establishment of treatment and prevention methods for low back pain is essential.[1] Decreased lumbopelvic stability causes abnormal changes in the neuromusculoskeletal system, resulting in low back pain and its recurrence.[2,3] Therefore, suppressing compensatory lumbopelvic movements and stabilizing the lumbopelvic region during therapeutic exercise is important in patients with low back pain and lumbopelvic instability.

The prone hip extension (PHE) test has been used to evaluate lumbopelvic stability. In patients with low back pain, excessive lumbar lordosis, anterior tilt, and pelvis rotation are observed as compensatory movements during PHE.[4] These compensatory movements are a characteristic pattern in patients with low back pain.[3] In addition, overactivity of the erector spinae and delayed onset time of the erector spinae and multifidus are characteristic features of patients with low back pain.[5,6]

For patients with low back pain and lumbopelvic instability, therapeutic exercises such as abdominal hollowing and abdominal bracing are available to decrease compensatory movements.[7] Abdominal hollowing aims to induce selective contraction of the transverse abdominis by pulling the umbilical region, while abdominal bracing involves co-contraction of the patients' trunk muscles. Suehiro et al.[8] found that abdominal hollowing and abdominal bracing contributed to spinal stabilization during PHE. However, previous studies were conducted with healthy participants, and it is unclear whether abdominal hollowing and abdominal bracing would have the same effects on patients with low back pain. However, the effects of abdominal bracing and abdominal hollowing on the spine are different, with abdominal hollowing having no direct mechanical impact on the spine and abdominal bracing promoting more effective stability patterns compared to AH.[7] Thus, abdominal bracing may be the preferred method for individuals with lumbopelvic instability. However, accurate abdominal bracing requires feedback from physical therapists or equipment such as an electromyography (EMG) unit, and there is a report of high subjective difficulty of abdominal bracing.[9] On the other hand, Dynamic Neuromuscular Stabilization (DNS) is a rehabilitative approach rooted in neurophysiology and developmental principles that involves using a series of functional tests to assess different patterns of postural stabilization.[10] DNS focuses on intra-abdominal pressure (IAP), which is beneficial because it is also used as an exercise to improve postural stabilization patterns in various limb positions and movements. Therefore, this study focused on IAP in DNS to stabilize the lumbopelvic region. For this study, the 'DNS maneuver' was defined as a technique with instruction according to the DNS principle that results in a coordinated activity of the diaphragm, pelvic floor, and abdominal wall.[11] In DNS, few people show an ideal pattern on functional testing, and like abdominal bracing, it is a technique with challenges for accurate implementation[10]; therefore, maintaining proper IAP and feedback by therapists is difficult.

Therefore, we hypothesized that wearing a trunk harness (Positive Motion Harness, Helinx) during movement could improve the effect of IAP and deep stabilization system. The trunk harness is an orthotic device made of elastic fibers wrapped from the rib cage through the abdomen to the femoral region. It may be useful in maintaining spine alignment. We hypothesized that the trunk harness has several potential advantages, such as assisting with muscle contraction, stimulating proprioceptors in the abdomen through external pressure, and reducing compensatory movements of the lumbar spine and pelvis during movement. Notably, Miyazaki et al.[12] reported that the thickness of the transversus abdominis improved by applying tape, indicating that the activity of deep trunk muscles may be changed with external stimulation. However, the relationship between compensatory movements of the lumbopelvic region during movement has not been reported. Wearing the trunk harness may contribute to proper spinal alignment, increase IAP, stabilize the lumbopelvic region, and improve the delayed onset of lumbopelvic muscles. The purpose of this study was to examine the effects of performing to improve DNS-maneuver with and without a trunk harness on the lumbopelvic stability and muscle activity of the trunk and hip joint muscles during PHE in healthy individuals, as well as in patients with low back pain.

Methods

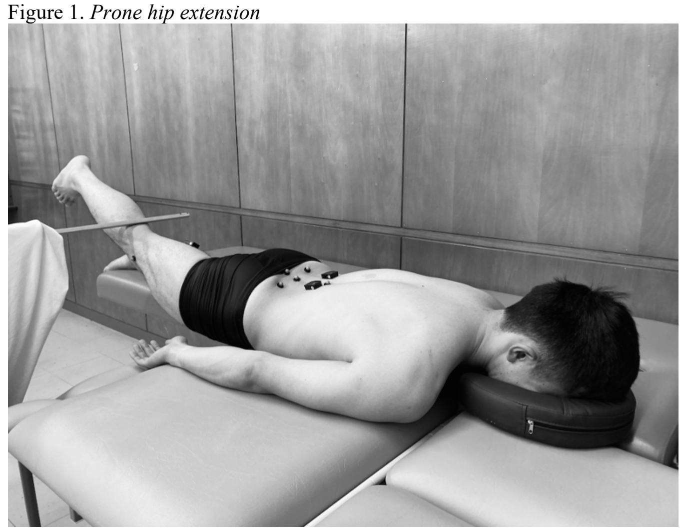
2.1 Participants

Thirty-one participants (15 healthy men and 16 men with low back pain) were included in this study. The inclusion criteria were male and 18 years of age or older. The exclusion criteria were a history of lumbar spine or hip surgery and a diagnosis or suspicion of serious spinal disease (inflammatory spinal disease, fracture, malignancy, cauda equina syndrome, or infection). Low back pain was defined as unilateral or bilateral pain between the 12th rib and the tailbone.[13] The Japanese Orthopedic Association Back Pain Evaluation Questionnaire (JOABPEQ) was used to identify patients with low back pain. If the functional score after treatment exceeded 90 points, the treatment was judged to be effective.[14] Hence, patients who scored below 90 on the pain-related disability score of JOABPEQ were included. This study was reviewed and approved by the Ethics Committee of Tokyo Metropolitan University (20046). This study was performed by the tenets of the Declaration of Helsinki, and written informed consent was obtained from all participants.

2.2 Experimental Procedure

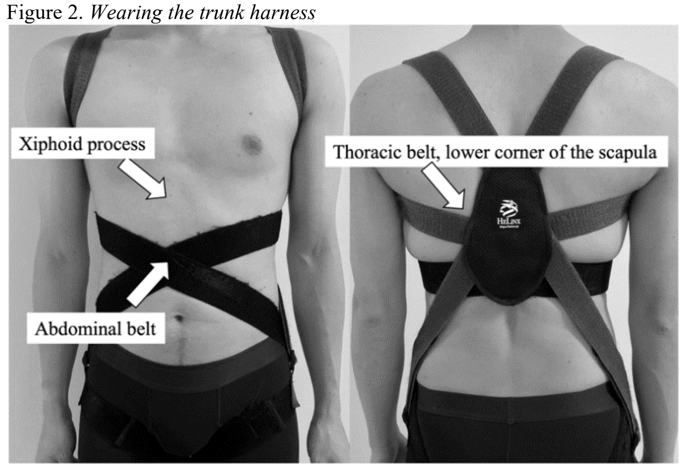
The prone hip extension was performed with the participant's dominant leg, i.e., the one used for kicking. The starting position of the PHE was prone to the hip joint at 30° flexion with the knee extended. A target bar was placed at 10° hip extension, and the participants were instructed to extend the hip joint with a signal and hold a touch bar for 5 s (Figure 1).

Figure 1. *Prone hip extension*



The prone hip extension was performed under three conditions: control condition, DNS-maneuver condition, and DNS-maneuver + harness condition. The order of the DNS-maneuver condition and the DNS-maneuver + harness condition was randomized. In the control condition, only verbal commands were provided. In the DNS-maneuver condition, participants performed PHE after the verbal instruction, "Please perform the movements while pushing with your abdominal wall and maintain during the whole movement." In the DNS-maneuver + harness condition, participants were asked to perform PHE with the trunk harness attached and, after the verbal instruction, "Please perform the movements while bulging your abdomen by pushing the abdominal belt and maintain during the whole movement." The trunk harness was wrapped as follows: the thoracic belt was set at the lower corner of the scapula, and the abdominal belt was crossed below the three lateral fingers of the xiphoid process and passed over the greater trochanter (Figure 2).

Figure 2. *Wearing the trunk harness*



Note. The thoracic belt was at the lower corner of the scapula. The abdominal belt was crossed below the three lateral fingers of the xiphoid process.

A pressure sensor (PG-100-102RP; Digi-Key Electronics, Inc.) was used to confirm that the pressure at the crossed region of the belt was within 25–35 mmHg during resting expiration. A 3-minute break was provided between each measurement condition to minimize carryover effects.

2.3 Data Processing

The measurement items were the pelvic motion angles, lumbar lordosis angle, muscle onset time, difficulty of movement during PHE, and JOABPEQ score. The pelvic motion angles were measured using a three-dimensional motion analysis system (Vicon Nexus, Vicon) with 12 cameras at a sampling rate of 200 Hz. The reflective markers were placed at the following sites: the T12 spinous process, L2 spinous process, bilateral anterior superior iliac spine (ASIS), bilateral posterior superior iliac spine (PSIS), S1 spinous process, S3 spinous process, and bilateral lateral femoral epicondyle. The reflective markers on the bilateral ASIS were used to define the segmental coordinate system, and the reflective markers on the bilateral PSIS and sacral region were used to track the pelvic segments. The segment definition method was based on a plug-in gait model.[15] The x-axis was defined as the line parallel to a line connecting the ASIS and PSIS midpoints, and the pelvic anterior tilt direction was defined as the positive direction. The y-axis was defined as a line parallel to a line connecting the right and left ASIS, with the right pelvic oblique in the positive direction. The z-axis was defined as the line perpendicular to the x- and y-axes, and the left rotation direction was defined as the positive direction. The pelvic oblique and rotation angles were calculated such that oblique and rotation to the same side of the moving leg were positive values. The pelvic motion angles were defined as the difference between the mean values obtained with 1 s of rest and 1 s of 5 s of PHE. The mean value of five trials was used for the statistical analysis. Initiation of lower leg movement was defined as the point at which the upward velocity of the lateral femoral epicondyle marker exceeded 5% of the maximal velocity.[16]

The lumbar lordosis angle was measured using a curved ruler (flexible curved ruler with a 40-cm scale, Shinwa Measurement Co.) The lumbar lordosis angles were measured by placing the ruler on the participants' T12–S2 spinous process. The straight line connecting T12–S2 was set as L, while the perpendicular line from the midpoint of the curve to L was set as H. The lumbar lordosis angle was measured by calculating 4Arctan (2H/L).[17-19] The lumbar lordosis angle was defined as the difference between the prone and PHE position angles. The mean values of three trials were used for the statistical analysis.

Muscle onset time was measured using wireless dry Ag surface electromyography (Delsys Trigno, Delsys, Inc.) with a 1.0 cm center-to-center inter-electrode distance. The four-electrode placement was attached to locations based on the Surface Electromyography for the Non-Invasive Assessment of Muscles (SENIAM) recommendations [20]: the bilateral erector spinae (at a 2-finger-width distance lateral from the spinous process of L1), gluteus maximus (50% on the line extending between the sacrum and greater trochanter), and semitendinosus (50% on the line extending between the ischial tuberosity and medial epicondyle). The band-pass filter was set to 20–450 Hz, and the measurement was performed at a sampling frequency of 1,000 Hz using an A/D converter (Giganet, VICON) of a three-dimensional motion analysis system. Baseline processing and smoothing were performed using the EMG analysis software (Delsys Analysis). To determine the onset time of muscle activity, the threshold of three standard deviations from the mean value observed at baseline was calculated. The muscle onset time was defined as the time when the EMG signal exceeded this threshold for more than 50 ms. The muscle onset time was normalized based on the initiation of the lower leg movement. Positive values indicated that muscle activity occurred later than the initiation of leg movement. The mean value of five trials was used for statistical analysis. The difficulty of the movements was measured using a visual analog scale. A value of 0 mm was classified as "very easy to raise" and 100 mm as "very difficult to raise." The severity of low back pain was assessed using the JOABPEQ in both groups. Difficulty was asked after each condition, and JOABPEQ was inquired after all trials were completed.

2.4 Statistical Analysis

The results of the JOABPEQ were compared using the Mann–Whitney U test. Repeated-measures two-way analysis of variance (ANOVA) was performed for each measurement item, with the participant group as a between-subjects factor and the difference in maneuver as a within-subjects factor. A multiple-comparison method with Bonferroni adjustment was used as a post-hoc test between the levels of factors that showed a main effect. IBM SPSS Statistics ver. 26 was used for statistical analysis, and the significance level was set at 5%.

Results

Table 1 shows the demographic data and JOABPEQ results for both groups. In JOABPEQ, the low back pain group showed significantly lower values for pain-related disability, lumbar spine dysfunction, gait dysfunction, and social life disability ($p < 0.05$). Table 2 shows both groups' lumbopelvic motion angle, motion difficulty, and muscle onset time. Repeated-measures two-way ANOVA showed no main effect of group and interaction. The maneuver showed significant main effects on the difficulty of movement, lumbar lordosis angle, pelvic anterior tilt angle, pelvic oblique angle, and muscle onset time of gluteus maximus and contralateral erector spinae ($p < 0.05$) (Table 3). Post-hoc analysis showed that the lumbar lordosis angle was significantly lower in the DNS-maneuver and DNS-maneuver + harness conditions than in the control condition ($p < 0.05$). The pelvic anterior tilt angle was significantly lower in the DNS-maneuver + harness condition than in the control and the DNS-maneuver conditions ($p < 0.05$). The pelvic oblique angle was significantly lower in the DNS-maneuver condition than in the control and the DNS-maneuver + harness conditions ($p < 0.05$). The muscle onset of GLUTEUS MAXIMUS and contralateral erector spinae were lower in the DNS-maneuver + harness condition than in the control and DNS-maneuver conditions ($p < 0.05$). The difficulty of the movements was significantly lower in the DNS-maneuver and DNS-maneuver + harness conditions than in the control condition ($p < 0.05$) and significantly lower in the DNS-maneuver + harness condition than in the DNS-maneuver condition ($p < 0.05$) (Table 4).

Table 1. *Demographic data and JOABPEQ scores in both groups*

	Healthy men (n = 15)	Low back pain (n = 16)	*p*-value	Effect size (*r*)
Demographic data				
Age (years)	22.1 ± 2.5	20.6 ± 1.4	-	-
Height (cm)	172.8 ± 6.4	174.6 ± 3.6	-	-
Weight (kg)	64.1 ± 12.6	67.6 ± 6.8	-	-
Right dominant leg (men)	13	13	-	-
JOABPEQ (points)				
Pain-related disability score	100.0 (100.0–100.0)	71.0 (43.0–71.0)	<0.01*	0.92
Lumbar dysfunction score	100.0 (100.0–100.0)	91.5 (81.0–100.0)	0.02*	0.56
Gait dysfunction score	100.0 (100.0–100.0)	100.0 (98.3–100.0)	0.04*	0.37
Social life disability score	100.0 (96.0–100.0)	81.0 (76.8–100.0)	0.01*	0.46
Psychological disability score	76.0 (57.0–85.0)	80.5 (72.0–89.3)	0.41	0.15

Note. Demographic data are described as values with mean±standard deviation, JOABPEQ data are described as values with median and 25–75 percentile values; JOABPEQ = Japanese Orthopedic Association Back Pain Evaluation Questionnaire
**: p < 0.05*

Table 2. *Lumbopelvic motion angle, motion difficulty, and muscle onset time in both groups*

	Healthy men (n = 15)			Low back pain (n = 16)		
	Control	DNS-M	DNS-M + harness	Control	DNS-M	DNS-M + harness
Kinematic data (°)						
Lumbar lordosis	7.30 ± 3.52	5.86 ± 2.94	3.78 ± 4.63	8.21 ± 2.65	5.10 ± 4.33	3.93 ± 3.38
Pelvis anterior tilt	6.63 ± 2.91	6.35 ± 3.15	5.06 ± 2.93	8.21 ± 2.65	8.27 ± 3.66	6.53 ± 3.72
Pelvis oblique	2.61 ± 4.26	1.63 ± 4.07	2.90 ± 4.86	2.09 ± 3.98	1.24 ± 4.48	2.15 ± 3.62
Pelvis rotation	−1.86 ± 1.80	−1.86 ± 1.78	−2.02 ± 2.21	−0.79 ± 1.78	−0.86 ± 1.94	−0.98 ± 2.14
Difficulty (mm)	45.2 ± 19.3	32.3 ± 21.2	22.7 ± 20.4	47.2 ± 19.1	27.1 ± 14.9	21.8 ± 17.4
Muscle onset time (ms)						
Gluteus maximus	−37.4 ± 54.7	−1.94 ± 110.8	−103.9 ± 91.4	−25.1 ± 82.2	−50.3 ± 81.9	−104.2 ± 51.5
Semitendinosus	−191.9 ± 55.8	−205.8 ± 95.8	−192.7 ± 54.5	−145.9 ± 66.6	−174.6 ± 122.6	−178.9 ± 64.9
Ipsilateral ES	−153.6 ± 48.6	−156.4 ± 123.5	−155.3± 97.0	−148.1 ± 89.8	−172.0 ± 71.6	−170.3 ± 58.4
Contralateral ES	−140.6 ± 42.4	−161.9 ± 123.5	−169.3 ± 182.2	−103.0 ± 99.3	−184.9 ± 112.5	−215.5 ± 90.2

Note. Values are mean ± standard deviation; IAP-M = intra-abdominal pressure-maneuver; ES = erector spina

Table 3. *Repeated-measures two-way analysis of variance*

	Group			Maneuver			Group*Maneuver		
	F value	*p*-value	η2	F value	*p*-value	η2	F value	*p*-value	η2
Lumbar lordosis	<0.01	0.99	<0.01	17.42	<0.01*	0.38	0.14	0.71	<0.01
Pelvic anterior tilt	2.31	0.14	0.07	9.44	<0.01*	0.25	0.16	0.85	<0.01
Pelvic oblique	7.64	0.01	0.21	6.18	<0.01*	0.18	0.15	0.86	<0.01
Pelvic rotation	2.28	0.14	0.07	0.42	0.66	<0.01	0.01	0.99	<0.01
Difficulty of PHE	0.05	0.82	<0.01	44.85	<0.01*	0.61	0.99	0.38	0.03
Gluteus maximus	0.24	0.63	<0.01	17.09	<0.01*	0.37	2.3	0.11	0.07
Semitendinosus	1.59	0.22	0.05	1.05	0.36	0.03	0.54	0.59	0.02
Ipsilateral ES	0.18	0.68	<0.01	0.24	0.79	<0.01	0.16	0.85	<0.01
Contralateral ES	0.1	0.75	<0.01	5.02	0.01*	0.15	1.76	0.18	0.06

Note. ES = erector spinae, PHE = prone hip extension
** p < 0.05 z*

Table 4. *Post-hoc analysis*

	Control vs. DNS-M			Control vs. DNS-M + harness			DNS-Mvs. DNS-M + harness		
	Mean difference	*p*-value	Effect size (*d*)	Mean difference	*p*-value	Effect size (*d*)	Mean difference	*p*-value	Effect size (*d*)
Lumbar lordosis	2.17 (0.75, 3.60)	<0.01*	0.61	3.80 (1.96, 5.64)	<0.01*	1.01	1.63 (−0.01, 3.26)	0.05	0.41
Pelvic anterior tilt	0.11 (−1.06, 1.29)	1	0.03	1.63 (0.64, 2.61)	<0.01*	0.5	1.52 (0.50, 2.53)	<0.01*	0.43
Pelvic oblique	0.92 (0.09, 1.75)	0.03*	0.21	−0.17 (−1.75, 0.57)	1	0.04	−1.09 (−2.04, −0.14)	0.02*	0.25
Pelvic rotation	0.03 (−0.3, 0.50)	1	0.02	0.16 (−0.36, 0.71)	1	0.08	0.14 (−0.40, 0.68)	1	0.07
Difficulty of performing PHE	16.48 (1.81, 22.15)	<0.01*	0.87	23.97 (16.93, 31.01)	<0.01*	1.24	7.49 (0.55, 14.43)	<0.01*	0.39
Gluteus maximus	−5.07 (−44.95, 34.81)	1	0.05	72.90 (38.72, 107.07)	<0.01*	1	77.97 (38.54, 117.39)	<0.01*	0.87
Semi-tendinosis	21.34 (−28.50, 71.18)	0.86	0.23	16.89 (−11.82, 45.59)	0.44	0.27	−4.45 (−41.65, 32.75)	1	0.05
Ipsilateral ES	13.35 (−42.81, 69.512)	1	0.15	11.96 (−39.02, 61.93)	1	0.16	−1.39 (−57.20, 54.41)	1	0.02
Contralateral ES	51.62 (−0.23, 103.47)	0.75	0.52	70.56 (3.07, 138.05)	0.04*	0.61	18.93 (−36.33, 74.19)	1	0.15

Note. Values are described as mean differences with 95% confidence intervals; AB = abdominal bracing, ES = erector spinae, PHE = prone hip extension
**: p < 0.05*

Discussion

The decrease in lumbar lordosis angle observed in the DNS-maneuver, and DNS-maneuver + harness conditions may result from lumbar stabilization due to activation of the abdominal muscle groups. Suehiro et al.[8] reported that the lumbar lordosis angle decreased significantly during PHE with abdominal hollowing and abdominal bracing compared to the normal condition, and abdominal muscles showed the highest muscle activity in the abdominal bracing condition. In this study, the abdominal muscles might have been activated in the DNS-maneuver and DNS-maneuver + harness conditions, reducing the lumbar lordosis angle. In the DNS-maneuver + harness condition, the anterior pelvic tilt angle significantly decreased, which implies that the lumbopelvic region was stabilized to a greater degree in the DNS-maneuver + harness condition than in the other conditions. The trunk harness originated from the rib cage, crossed at the abdomen, and wrapped around the hip joint. Thus, the spinal column was thought to be stabilized by wrapping, e.g., by the external pressure of the thorax to the hip joint. In addition, in the DNS-maneuver + harness condition, the participants performed PHE by pushing the abdominal belt. Therefore, we consider it more straightforward to stimulate the contraction of the abdominal muscles when wearing the trunk harness because it is easier for patients to be aware of their abdomen muscles when feeling the external pressure from the trunk harness. For these reasons, the DNS-maneuver + harness condition was more likely to increase the activity of the abdominal muscle groups than the DNS-maneuver condition, resulting in a significant decrease in the anterior pelvic tilt angle.

The onset of gluteus maximus in the harness condition was significantly earlier than in the other conditions, and the onset of contralateral erector spinae was considerably earlier than that in the control condition. The multifidus and contralateral erector spinae activity in PHE is a feed-forward controlled activity.[6] Moreover, a significant correlation has been reported between the amount of anterior pelvic tilt angle and the delay in the onset of bilateral multifidus and contralateral erector spinae during PHE.[6] The delay in the onset of gluteus maximus is associated with abnormal movements, such as excessive lumbar lordosis and rotation during PHE, even in healthy individuals.[21] Therefore, altering the onset time of muscle activity in the DNS-maneuver + harness condition is advantageous for stabilizing the lumbopelvic region. The factors contributing to these changes might be the stabilization of the lumbopelvic region in the DNS-maneuver + harness condition, greater stimulating activity of the abdominal muscles, and the change in the lumbar lordosis angle. The onset time of gluteus maximus was accelerated in PHE with AH,[22] and training for neuromuscular control of the lumbopelvic region and hip joint affects muscle activity patterns. In this study, the lumbopelvic region was stabilized, and the muscle activity pattern was improved in the DNS-maneuver + harness condition compared to the DNS-maneuver condition. These results suggest that the trunk harness may help improve lumbopelvic stability and muscle activity patterns.

This study showed no decrease in the anterior pelvic tilt angle or muscle onset time in the DNS-maneuver condition. These results differ from those of several previous studies,[8,22] possibly because of differences in the intervention methods used in previous studies. Previous studies employed feedback using surface EMG and pressure biofeedback devices to perform abdominal hollowing and AB accurately.[8,22] In this study, only verbal instructions were provided for the DNS-maneuver, and DNS-maneuver + harness conditions. We did not use ultrasound imaging to check whether the DNS-maneuver was accurately performed. As a result, some participants may have been unable to increase trunk muscle activity and IAP during the DNS-maneuver condition. These results suggest that the accurate performance of abdominal hollowing, abdominal bracing or DNS-manuever may be difficult without feedback. In the DNS-maneuver + harness condition, participants pushed the abdominal belt, which may have facilitated the focusing of the abdominal muscles, including the deep trunk muscles. As a result, the difficulty of the movements decreased more in the DNS-maneuver + harness condition than in the other conditions. These results suggest that wearing a trunk harness is more effective in stabilizing the lumbopelvic region and improving muscle activity patterns during PHE than in conventional abdominal hollowing and abdominal bracing conditions.

This study showed no significant differences between healthy individuals and patients with low back pain in each measurement item, except for the JOABPEQ scores. This may be because the patients with low back pain in this study included those with mild conditions and those who did not have lumbopelvic instability. This study used a questionnaire survey among university students and adults to select patients with low back pain. Still, the pain in most of these patients did not interfere with their daily lives. Therefore, many of the participants in this study had relatively mild LBP; thus, there were no significant differences between healthy individuals and patients with low back pain. Sahrmann[4] reported that excessive lumbar lordosis and excessive anterior tilt and rotation of the pelvis are compensatory movements during PHE in patients with low back pain during clinical observation. However, the angle of lumbar lordosis is significantly decreased in these patients,[17] and the angle of lumbar lordosis decreases during movement in patients with non-specific chronic low back pain.[18] Therefore, there is no standardized view on the movement of the lumbopelvic region during PHE in individuals with low back pain. One of the reasons for this is the need to subgroup patients with low back pain. In recent years, the importance of subgrouping patients with low back pain has been discussed.[23] Some patients have hypermobility or hypomobility of the lumbar spine.[24] In this study, we did not evaluate the mobility of the lumbar spine; therefore, patients with hypermobility and hypomobility may have been included as participants. As a result, no significant difference was observed between healthy individuals and patients with low back pain. However, there is no gold standard measure for lumbopelvic instability, and it is necessary to consider a multidimensional perspective.[25] This study also showed that lumbar kinematic patterns were similar in both groups, indicating that muscle activation and lumbar kinematic patterns are not as important as previously discussed. In the future, it will be necessary to investigate the effectiveness of exercise therapy with trunk harnesses in patients with low back pain who are selected using more rigorous eligibility criteria.

This study had some limitations. First, we did not measure the activities of deep trunk muscles such as the multifidus and transversus abdominis muscles. Second, we did not conduct long-term intervention studies using the trunk harness; therefore, the harness's long-term effect is unclear. Further, the participants of this study were young; hence, further investigation of the broader population is needed to generalize the results. Lastly, we did not classify participants with low back pain based on the mobility of the lumbar spine, and we may have included patients with mild low back pain. In the future, it will be necessary to examine the effects of lumbar stabilization exercises using a trunk harness on the deep trunk muscles with a long-term intervention.

Conclusion

In the present study, we compared lumbopelvic motion and trunk hip muscle activity during PHE in healthy individuals and patients with low back pain using a trunk harness. The results showed that wearing the trunk harness effectively stabilizes the pelvic region and changes muscle activity patterns.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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