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Original Article

The effect of core stabilization exercise on lumbar joint position sense in patients with subacute non-specific low back pain: a randomized controlled trial

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Abstract. [Purpose] This study aimed to examine the effect of core stabilization exercise (CSE) on joint position sense, pain intensity, and functional disability in patients with subacute non-specific low back pain (NSLBP). [Participants and Methods] Thirty-eight participants with subacute nonspecific low back pain of 6–12 weeks duration, aged 18–60 years, were included in this study. Participants were randomly divided into two groups: a core stabilization exercise group (n=19) or a control group (n=19). Outcomes measures included lumbar joint repositioning error (LJRE), numeric pain rating scale (11-NRS), and the Roland-Morris disability questionnaires (RMDQ). Measures were taken at baseline, 4 weeks, 7 weeks of intervention, and at 4 weeks after the last intervention. [Results] All outcomes measures were significantly improved in the core stabilization exercise group, compared with the control group. [Conclusion] Core stabilization exercise can improve acuity of joint position sense, reduce pain, and functional disability compared with thermal therapy. The finding demonstrated that core stabilization exercises are more suitable for patients with subacute NSLBP than thermal therapy and this should be useful to clinicians.
Key words: Low back pain, Exercise, Joint sense

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INTRODUCTION

Low back pain (LBP) is the most common musculoskeletal disorder and is a costly problem[1)]. More than 90% of LBP cases are classified as non-specific low back pain (NSLBP) because the precise cause is unclear[2, 3)]. Impaired local trunk muscle activation and reduced proprioceptive acuity in patients with LBP may alter muscle recruitment patterns which may cause motor control dysfunction and more compressive load to the spine, resulting in recurrent LBP[4)]. A possible hypothesis is that changes in motor planning, via the direct influence of pain on the motor centers, compromise feedback control and lead to poor lumbar joint position sense[4–6)].

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In subacute NSLBP, disrupted afferent information may alter local trunk muscle activation and cause poor joint position sense[7–9] which in turn leads to repeated microtrauma and recurrent pain. Systematic reviews of randomized controlled trials in patients with subacute LBP conclude that active exercise is effective in managing this disorder[10]. Extension and flexion exercises are the most widely used to reduce pain and disability[11–13]. However, these exercises may not address lumbar joint position sense, which is a key problem in subacute NSLBP. Research guidelines recommend core stabilization exercise (CSE) as a commonly used treatment strategy for chronic LBP[14–19]. CSE involves the activation and training of deep core muscles transversus abdominis (TrA) and lumbar multifidus (LM), with minimal activity of the superficial muscles[19–23]. Low-threshold recruitment of local and global muscle systems is important to provide modulation of the CNS for efficient motor integration of the muscles and may enhance joint position sense[24–26]. However, to our knowledge, the effect of CSE as an active treatment on lumbar joint position sense in patients with subacute NSLBP has never been explored.

The purpose of this study was to investigate the effect of CSE on lumbar joint position sense, pain intensity, and functional disability in patients with subacute NSLBP. We hypothesized that CSE might be an appropriate therapeutic exercise to provide clinical benefits in patients with subacute NSLBP.

PARTICIPANTS AND METHODS

This study was an assessor-blinded, randomized controlled trial. Participants were recruited from the physical therapy clinic, Khon Kaen University, through advertisements on social networks. The study protocol was approved by the Ethics Committee for Human Research at Khon Kaen University, Thailand (Reference number: HE572309) and registered at clinicaltrials.gov (Registration number: NCT02645760).

Participants with subacute NSLBP of between 6 to 12 weeks duration, aged between 18 and 60 years; mean age 38.76 ± 10.3 years, weight 60.71 ± 10.5 kg and height 157.42 ± 8.1 cm, and had a pain intensity of at least 3 out of 10 on an 11-point numeric rating scale (11-NRS) were included. Exclusion criteria were spinal surgery, suspected serious spinal abnormality, or pregnancy. A prior sample size was estimated based on the joint reposition sense at 1-month follow-up, and assuming 80% power and 5% significance. A total of 38 participants was required to detect a clinically meaningful difference of 0.4 cm on the joint reposition sense between the groups from our pilot study.

Participants were initially screened using an interview. Written informed consent was obtained from all participants before they enrolled in the study and received a physical examination. Lumbar joint position sense, pain intensity, and functional disability were measured by an assessor who was blinded to group allocation and treatment, at baseline, after 4 and 7 weeks of intervention, and at 11 weeks follow-up.

After performing pre-test assessments, participants were randomly allocated to either the CSE group or control group and stratified by age group to achieve an approximate balance between groups. Random numbers were computer generated and kept in sealed envelopes with consecutive numbering. The randomization process was performed by an assistant researcher.

All participants were treated by physiotherapists for 20 minutes a session, twice per week for 7 weeks in the Physical Therapy Laboratory, Khon Kaen University, Thailand. They were requested not to participate in any other physical programs, and to record drugs and any side effects of the intervention in a diary log book during the study.

Participants in the CSE group were supervised to perform exercises based on criteria recommended by Puntumetakul and coworkers[19]. CSE activates transversus abdominis (TrA) and lumbar multifidus (LM) muscles. In week 1–2, the researcher trained the participants how to contract TrA and LM muscles simultaneously with an abdominal drawing-in maneuver (ADIM) technique in low load positions of the spine (lying). Exercises in week 3–7 focused on increasing the precision and duration of co-contraction of the 2 muscles with controlled movements of upper and lower extremities and progressed to high load positions (sitting, standing). The program consisted of 10 repetitions with 10-second holds in each repetition. All participants were asked to perform home exercises for 15 minutes every day and record them in their diary. Exercise performance was re-assessed at each session to determine whether the participants could successfully perform the exercises.

Thermal therapy, hydrocollator and therapeutic ultrasound are the standard treatment widely used for LBP management in Thailand[27]. These are effective in alleviating the pain and disability in patients with LBP and were used in the second intervention group in this study. Participants in the control group received 5 minutes of therapeutic ultrasound using a 1-MHz ultrasound frequency with an intensity of 0.8–1.0 W/cm^2 on continuous mode (Enraf Nonius Sonoplus 434, ENRAF, Netherlands). After that, each of the participants received 15 minutes of heat via a hydrocollator pack (60°C) (Enraf-Nonius Medical Equipment Company Ltd., Bangkok, Thailand), which was placed over the painful area of the lower back in a prone lying position (Fig. 1).

Joint repositioning sense was used to assess the lumbar joint repositioning error. All participants sat with feet supported, hips and knees flexed 90 degrees. A 10-cm tape measure was placed on the lower lumbar area with the 0 cm of tape measure marking on the sacral segment 1 (S1), as the start point of measure and marked by a stable based (tripot) laser pointer Fig. 2. Each participant was asked to remember the starting position (neutral position) and maintain it for 5 seconds, then to move their pelvis from the maximum anterior to the maximum posterior tilt, maintain each position for 5 seconds, and return to the starting position. With the laser point on the tape-measure, the distance from the starting point (repositioning error) was measured in centimeters. Participants were allowed to practice twice before the examination started. The test was performed 3 times using rest intervals of 1 minute, and the average values were used for the analysis.

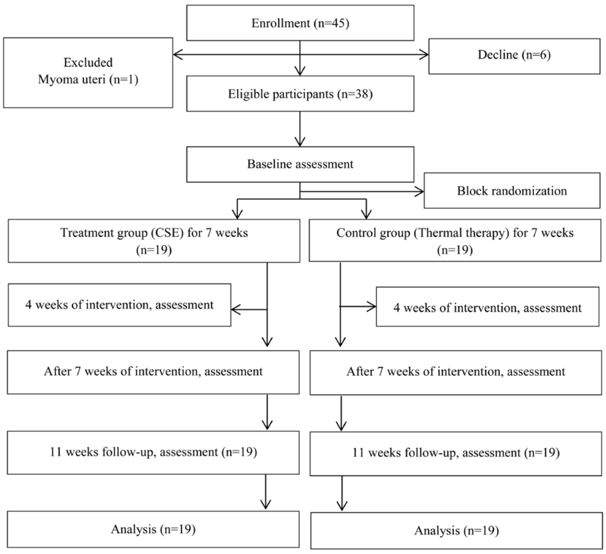

Fig. 1. Flow of participants through the study.

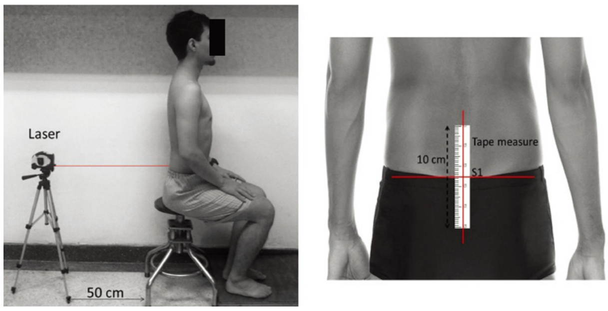

Fig. 2. Measurement positioning for joint repositioning error.

The 11-NRS was used to assess the current, minimum, and maximum levels of pain intensity at rest[28, 29] and the Thai version of the Roland-Morris disability questionnaire (RMDQ) was used to assess LBP-related functional disability[30, 31].

SPSS version 21.0 for Windows (IBM Corp., Armonk, NY, USA) was used to analyze data. Normality of the data was calculated with the Shapiro-Wilk test. Nonparametric statistics were used to analyze outcome variables as the data were not normally distributed. The Mann–Whitney test was used to analyze differences between groups separately at each time point and the change in scores for each outcome variable. Friedman's analysis of variance (ANOVA) was used to compare continuous outcome variables between baseline and at each time point in both groups. In this study, the significant level was set at $p<0.05$.

RESULTS

All demographic data and baseline clinical characteristics were equally balanced between the groups ($p>0.05$); (Table 1).

The CSE group had significantly reduced joint repositioning error, compared with the control group at 7 weeks of intervention ($p=0.048$) and at 4-week follow-up periods ($p<0.001$) with the effect size 0.628 and 1.421, respectively.

In addition, at 4 weeks of the intervention, 7 weeks of the intervention, and at 4-week follow-up, CSE group more significantly reduced pain intensity at rest than the control group ($p<0.001$) with the effect size 1.465, 1.755 and 2.269, respectively and functional disability ($p<0.001$) with the effect size 1.171, 0.997 and 1.157, respectively.

These results illustrated that the treatment group had a significant decrease in lumbar joint repositioning error, pain intensity at rest, and functional disability from baseline to each follow-up period, respectively. However, the control group recorded no significant changes of lumbar joint repositioning error from baseline at each follow-up period. For other outcome variables, pain intensity at rest and functional disability, a significant reduction occurred in both treatment and control groups from baseline to each follow-up ($p<0.001$). The mean and standard deviation (SD) of comparisons between the treatment group and the control group for all outcome variables are shown in Table 2.

DISCUSSION

The results of the study showed that the CSE group had significant improvements in lumbar repositioning sense, reduced pain intensity at rest, and functional disability compared with the control group at all measurement time points. Lumbar joint repositioning error significantly reduced after intervention and at 11 weeks follow-up in the CSE group, whereas, it increased in the control group in post training assessment. This suggests that lumbar joint reposition sense deteriorates in patients with subacute NSLBP who do not exercise their core muscles. CSE may also have a retaining effect on improving lumbar joint position sense. As increases in muscle activity stimulate muscle spindles and joint receptors; the accuracy of the sensory integration procedure is enhanced empowering precise joint repositioning[26].

In the present study, the CSE program decreased resting pain intensity and functional disability in patients with subacute NSLBP. Improved function increases patients' ability to complete activities of daily living. Although physical modalities (Ultrasound and thermal therapy) given to the control group also reduced their pain and functional disability, CSE has more

Table 1. Baseline demographic and clinical characteristics of the participants

Characteristics	Total (n=38)	Treatment group (CSE) (n=19)	Control group (n=19)	p-value
Female gender, n (%)	34 (89.5)	16 (84.2)	18 (94.7)	
Age (years)	38.8 ± 10.3	39.6 ± 10.3	37.9 ± 10.6	0.661
Height (cm)	157.4 ± 8.1	157.9 ± 9.4	156.9 ± 6.8	0.696
Weight (kg)	60.7 ± 10.5	62.3 ± 9.9	59.1 ± 11.0	0.353
Body mass index (kg/m^2)	24.5 ± 3.7	24.9 ± 3.1	24.0 ± 4.3	0.443
Low back pain duration (weeks)	8.4 ± 2.5	8.3 ± 2.4	8.4 ± 2.5	0.943

Values are presented as the mean ± SD; Age, Height, Weight, BMI, Body mass index and Low back pain duration.

Table 2. Comparison of treatment group (n=19) and control group (n=19) on lumbar joint repositioning error, pain intensity at rest and functional disability

Variables	Mean ± Standard deviation		Mean differences between groups	p-value (between group)
	Treatment group (CSE)	Control group		
Lumbar joint repositioning error (LRPE) (cm)				
Baseline	0.8 ± 0.4	0.6 ± 0.4	0.2	0.109
4 weeks of intervention	0.6 ± 0.3†	0.7 ± 0.4	−0.1	0.659
7 weeks of intervention	0.4± 0.3†	0.7 ± 0.4	−0.2	0.048*
4-week follow-up	0.4 ± 0.2†	0.7 ± 0.3	−0.4	<0.001**
Pain intensity at rest (0–10 NRS) (scores)				
Baseline	5.1 ± 0.9	5.4 ± 1.4	−0.3	0.560
4 weeks of intervention	2.1 ± 1.8†	4.6 ± 1.6†	−2.5	<0.001**
7 weeks of intervention	1.3 ± 1.8††	3.6 ± 1.6†	−2.3	0.001*
4-week follow-up	0.7 ± 0.9††	3.9 ± 1.8†	−3.2	<0.001**
Functional disability (RMDQ) (scores)				
Baseline	6.8 ± 4.3	8.8 ± 5.3	−2.0	0.246
4 weeks of intervention	2.4 ± 2.9††	6.8 ± 4.5†	−4.4	0.001*
7 weeks of intervention	1.5 ± 2.3††	4.9 ± 4.2††	−3.4	0.001*
4-week follow-up	0.8 ± 1.6††	4.0 ± 3.5†	−3.2	0.001*

For between group *Significant different at p<0.05, **Significant different at p<0.001.
For within group †Significant different at p<0.05, ††Significant different at p<0.001.

clinical advantages to improve subacute NSLBP. CSE may enhance activation of local trunk muscles and improve coordination of the trunk muscles, which is important for improving the stability of the lumbar segment and reducing spinal overload. Based on our findings, we recommend that patients with subacute NSLBP should receive CSE rather than passive treatment (US and thermal therapy) to reduce pain intensity. There were no adverse effects found in either groups during the study.

The findings of the study also concluded that a moderate correlation was observed between disability and pain in patients with subacute NSLBP in CSE group at 4 weeks of intervention (r=0.506) (p=0.027), and at 7 weeks of intervention (r=0.647) (p=0.003), but no correlation was found at 4-week follow-up. In the control group, no correlation was found in every time point of assessment." This result is similar to data reported by Roland and Morris[31)] and Hides and colleagues[32)] who examined the relationship between pain and back disability in patients with acute LBP. Enhancing back movement performance and improvement in joint reposition sense may also improve functional disability. The ability to hold a co-contraction pattern between TrA and LM muscles may develop specific motor control and help to restore kinesthetic awareness and lumbo-pelvic position sense. Our study confirms that the CSE program, especially the first stage of the program, could improve lumbar joint reposition sense impairment in patients with subacute NSLBP.

Although NSLBP has unknown causes, previous studies suggested that motor control deficits may reduce lumbar joint reposition sense and this may cause repeated micro-trauma and recurrence of LBP. Alternatively, pain may lead to changes in motor control. Possible mechanisms have been proposed that pain may affect motor control and change motor planning via the direct influence of pain on the motor centers. It can be surmised that all of these problems lead to poor lumbar joint position sense[4, 5)].

The effect size of the present study between treatment and control groups is 1.421, and this effect size demonstrates that statistically significant effects between groups. The sample size (n=19) per group in this study was sufficient to address the existing knowledge gap. Although the between-group mean difference on the joint reposition sense was 0.35 cm and less than clinically meaningful difference (0.4 cm) set from our pilot study, it had high statistically significant difference and effects size. Thus, we believe that these changes are likely to reach clinical significance. In addition, the minimal detectable change on the joint reposition sense in the previous study was 0.24 cm (Enoch et al.)[33]. Therefore, the mean different found from our study may be useful for clinical relevance. A limitation of this study was that muscle activity was not assessed directly, such as with electromyography (EMG), further studies are required to measure the effect of CSE on trunk muscles activity.

CSE is effective in patients with subacute NSLBP in improving acuity of lumbar joint position sense, improving functional ability and decreasing pain, and provides clinicians with a useful treatment intervention.

Conflict of interest

None.

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