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Effects of Sling Exercise on Pain and Disability in Patients with Chronic Low Back Pain: Meta-Analysis of Studies in Korea

Background: Various treatments have been proposed for chronic low back pain (CLBP), but recent guidelines and reviews recommend regular physical exercise. However, some other studies have reported opposite results that sling exercise (SE) and other exercises (OE) did not differ in improving CLBP.
Objectives: To systematically review and meta-analyze the effects of SE on CLBP in studies published in Korea.
Design: A Systemic Review and Meta-analysis.
Methods: Randomized controlled trials comparing SE with OE and modality therapy (MT), published up to June 2020, were identified by electronic searches. Primary outcomes were pain and disability. The weighted mean difference (WMD), stand mean difference (SMD) and 95% confidence interval (CI) were calculated using a random-effects model.
Results: Based on the results of the meta-analysis, SE was effective for pain in the comparison of SE and MT [short-term: WMD=-1.64, 95% CI (-3.06, -0.22); long-term: WMD=-0.34, 95% CI (-0.42, -0.26)]. It was effective for pain in the comparison of SE and OE [short-term: WMD=-1.18, 95% CI (-2.15, -0.20); long-term: WMD=-0.66, 95% CI (-0.89, -0.43)]. It was also effective for disability in the comparison of SE and MT [short-term: SMD=-15.82, 95% CI (-23.10, -8.54)]. We found no clinically relevant differences in disability between SE and OE. Heterogeneity was high in the comparison of SE and overall variables.
Conclusion: If SE is applied to physical therapy to improve the main symptoms of CLBP patients, it may contribute to their recovery. More high-quality randomized studies on the topic are warranted.

Keywords: *Chronic low back pain; Sling exercise; Pain; Disability; Meta-analysis*

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INTRODUCTION

About 85% of people experience low back pain (LBP) during their lifetimes.[1,2] LBP is a major cause of disability worldwide.[3] Acute LBP can be treated within 6 weeks.[4] However, 71% of patients with acute LBP do not fully recover.[5] In this case, LBP over 12 weeks is defined as chronic low back pain (CLBP).[6,7] Prior studies have shown that hospitalization and physical therapy incur large medical costs for managing LBP.[8] CLBP is common in adults over 40 and leads to psychological problems such as low job satisfaction, anxiety, depression, and negative perception.[9]

CLBP treatment is also needed for social and economic reasons. Many medical doctors rely on nonsteroidal anti-inflammatory drugs, opioids, and neurotropic medications, or steroid injections and surgery as their main tools.[10] However, in recent years, non-pharmacological approaches have become popular.[11] Various treatments have been proposed for the treatment of CLBP, but recent guidelines and reviews recommend regular physical exercise.[12,13] Several previous studies also reported that exercise can be compared to other conservative treatments to improve the pain intensity and disability of CLBP.[14,15]

Among the various exercise methods, sling exercise

(SE) is widely used in hospitals and treatment rooms to manage high risks because the suspension mechanism attached to the ceiling provides an unstable device.[16,17] SE has several features. Firstly, the SE is weight-bearing training that adjusts muscle co-activation to stabilize joints. Secondly, SE intensity can be controlled with elastic cords that can unload body weight.[18] Thirdly, it is an efficient exercise for normalizing muscle response pattern, adjusting postural balance, and reducing pain in patients with CLBP.[19-21]

Looking at previous studies on SE, it was reported that SE improved CLBP more than other exercise methods.[22] However, some other studies have reported opposite results that SE and other exercise (OE) did not differ in improving CLBP.[23] Therefore, the effectiveness of SE compared with other treatments remains unclear.

As far as we know, Korea uses and studies SE more than any other country.[24] However, in the systematic review and meta-analysis study, the Korea database is not included. So studies published in Korea has limitations that are not known worldwide. Therefore, the purpose of this study is to systematically review and meta-analyze the effects of SE on CLBP in studies published in Korea.

METHODS

This study was conducted with the approval of the research by the Institutional Review Board of Nambu University (IRB: 1041478-2020-HR-029). This study was performed in accordance with PRISMA guidance, ensuring a rigorous approach.

Literature Search

The following databases were searched from the earliest available date to June 2020: Research Information Sharing Service, Korean Studies Information Service System, National Digital Science Library, DBpia, Earticle, scholar, and National Assembly Library. We used the search terms "Low Back Pain," "Sling," and "Sling Exercise" in Korean and English.

Inclusion Criteria

Types of studies

Only randomized controlled trials (RCT) investigating the use of SE as a treatment for CLBP were included.

Types of participants

The study samples included patients with CLBP affected for longer than two months. University students, minors, and non-hospital gym customer studies were not included.

Types of interventions

We included articles in which SE was compared with modality treatment, as well as any OE treatment for CLBP.

Types of outcome measures

The findings were analyzed in two primary outcome categories: pain and disability. We categorized outcomes as short term (post-treatment assessment no longer than 6 weeks) or long term (≥12 weeks).

Selection of Studies

The two independent reviewers (First Author, Corresponding author) screened for potentially relevant titles and abstracts based on the pre-specified criteria (PICOS), and full-text articles were retrieved whenever necessary. If a journal article and thesis paper were duplicated, the journal article was adopted. Disagreements were resolved by the principle of majority voting, including the views of co-authors.

Data Extraction

The two independent reviewers (First Author, Corresponding author) abstracted and cross-checked the data obtained from the included trials. These data were then compiled in a pre-designed data extraction form. Disagreements were resolved by the principle of majority voting, including the views of co-authors.

Quality Assessment

The two independent reviewers (First Author, Corresponding author) used the Cochrane Collaboration's risk of bias tool to evaluate the methodological quality of all included studies. The following domains were evaluated: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessments, incomplete outcome data, selective reporting, and other bias. For each domain, each study's description of methods was examined and a judgment regarding potential bias was made according to three categories: low risk, high risk and unclear risk. Disagreements were resolved by the principle of majority voting, including the views of co-authors.

Statistical Analysis

Meta-analysis procedure was performed with Revman 5.4. The random effects model was used to estimate the mean of the distributions of the effect sizes of different populations. WMD was used when individual studies were in the same unit. SMD was used when individual studies were different units. A chi-square test was performed to detect statistically significant heterogeneity. We then estimated the amount of heterogeneity among studies by using the I^2 statistic: 〈25%, low; 〈50%, moderate heterogeneity; and 〉50%, substantial heterogeneity. Heterogeneity was further investigated by checking data extracted from outlier studies and exploring the effects of study exclusion in sensitivity analyses. No funnel plots or assessments for publication bias were performed because of the small number of studies (maximum three studies) that were pooled in the comparisons included in this literature. The control conditions were divided into two groups: Modality therapy and other exercise. We then performed separate subgroup analyses for short-term and long-term follow-up time points. One study included two different control groups, which were individually considered during analysis.

RESULTS

Literature Search

We initially retrieved 759 articles (Journal: 516, Thesis: 243) from the databases that were relevant to the search terms. Eight studies were finally included for analysis (Figure 1).

Study characteristics

We included eight single-center randomized controlled studies with the aim to examine the efficacy of SE on CLBP.[25-32] These were four journal articles and four theses. They were published between 2012 and 2018. One study was published in English, and the rest were published in Korean. The summarized characteristics of the studies included in our systematic review are presented in Table 1.

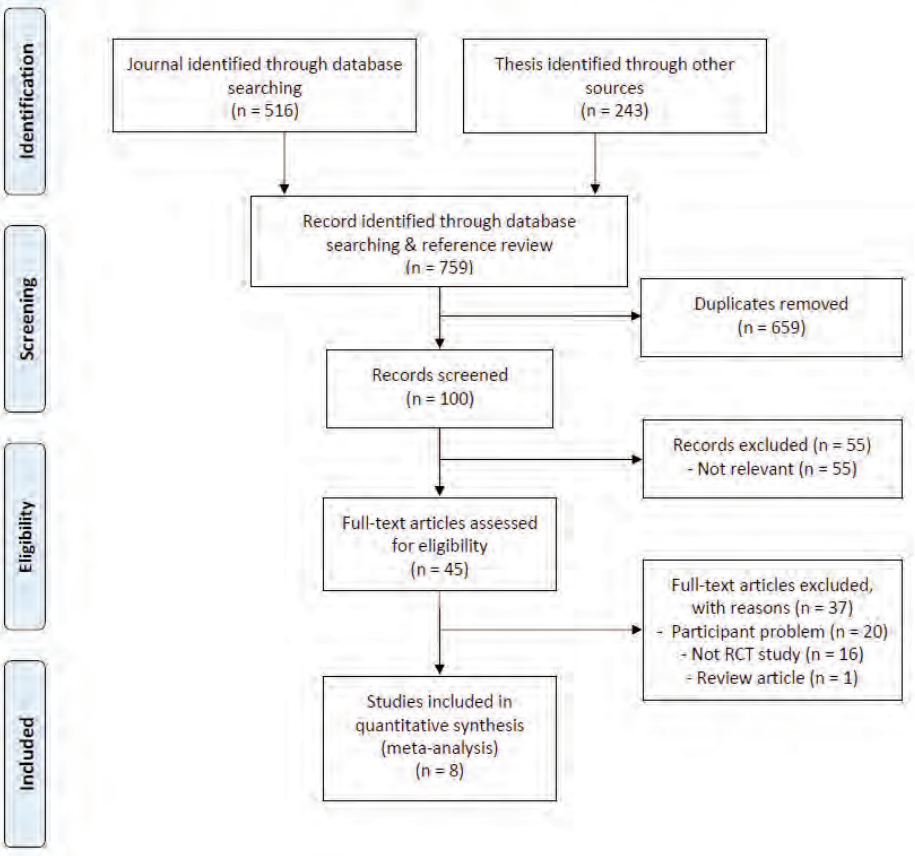


Figure 1. Flowchart of the study selection process

Table 1. Characteristics of studies included in the analysis

Authors (years)	Publication type	Disease period	Intervention		Duration (week)	Number (total)	Time (min)	Outcomes	
			Sling (n)	Control (n)				Pain	Disability
Ha et al. (2012)	Journal	2<	SE (9)	MCE (11)	4	8	40	VAS	ODI
Kim (2013) (1)	Thesis	3<	SE (11)	MT (10)	6	18	30		ODI
Kim (2013) (2)	Thesis	3<	SE (11)	MT (10)	6	18	30		ODI
Park (2013)	Thesis	3<	SE + LSE (10)	MT (10)	4	12	60	VAS	ODI
Cho (2015) (1)	Thesis	3<	SE (10)	MT (10)	4	16	50	VAS	ODI
Choi (2015) (2)	Thesis	3<	SE + TM (10)	MT (10)	4	16	50	VAS	ODI
Kim et al. (2017)	Journal	3<	SE (15)	ME (15)	4	12	20	VAS	ODI
Kim & Kim (2018)	Journal	3<	SE + VI (35)	RE (35)	12	36	30	VAS	
Park et al. (2018)	Journal	3<	SE (55)	MT (61)	12	36	50	VAS	
Woo (2018) (1)	Thesis	3<	SE (10)	USSE (10)	6	12	30	VAS	ODI
Woo (2018) (2)	Thesis	3<	SE (10)	ME (10)	6	12	30	VAS	ODI

SE: sling exercise, MCE: motor control exercise, VAS: visual analogue scale, ODI: oswestry disability index, MT: modality therapy, LSE: lumbar stabilization exercise, TM: thoracic mobilization, ME: mat exercise, VI: vibration, RE: resistance exercise, USSE: unstable supporting surface exercise

Methodological Quality of Included Studies

The eight studies were randomized, but no details were provided.[25-32] We could not determine the allocation concealment of the eight studies.[25-32] None of the studies met the criterion of blinding of participants and outcome assessors.[25-32] Given the direct participant involvement due to the nature of therapeutic trials, and self-reported outcome measures such as pain and disability, it was not feasible to blind participants and outcome assessors.[25-32] The risk of incomplete outcome data was low for only six included studies.[25,27-30,32] Selective outcome reporting was at a low risk of bias in all eight included studies[25-32], while sources of other bias were unclear.[25-32] Figure 2 shows the detailed results of the quality assessment of individual characteristics.

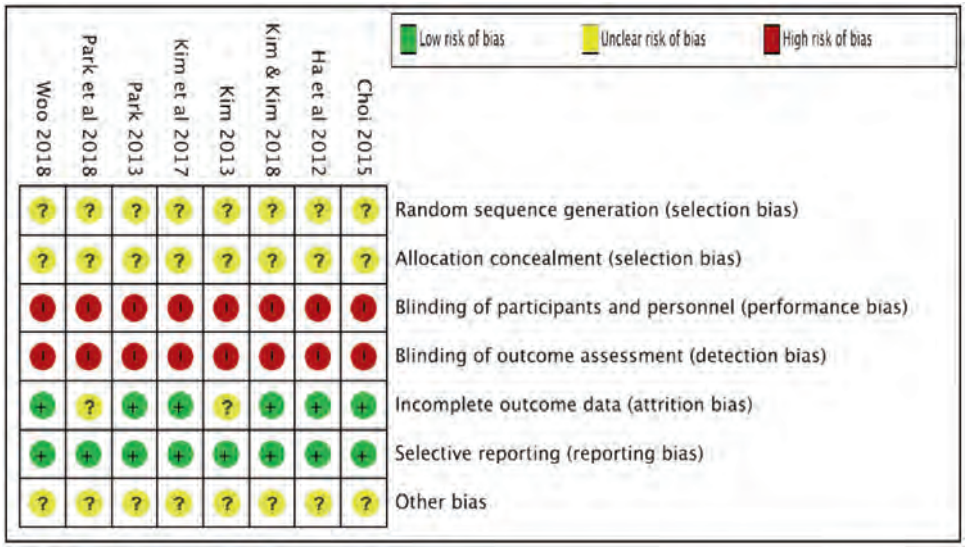


Figure 2. Methodological evaluation of RCT study using Risk of Bias tool

Comparison of SE and MT for pain

The studies comparing SE with MT revealed significant short-term [WMD=−1.64, 95% CI (−3.06, −0.22), P<0.00001] and long-term [WMD=−0.34, 95% CI (−0.42, −0.26)] differences in pain (Figure 3). The heterogeneity for short-term pain was substantially high (I^2=99%). A meta-analysis excluding Choi 2015 (b) reduced heterogeneity (I^2=95%) and revealed a statistically significant effect size [WMD=−0.92, 95% CI (−1.90, 0.06), P<0.00001].

Comparison of SE and OE for pain

The studies comparing SE with OE revealed significant short-term [WMD=−1.18, 95% CI (−2.15, −0.20), P<0.00001] and long-term [WMD=−0.66, 95% CI (−0.89, −0.43)] differences in pain (Figure 4). The heterogeneity for short-term pain was substantially high (I^2=97%). A meta-analysis excluding Woo 2018 (a) and (b) reduced heterogeneity (I^2=0%) and revealed a statistically non-significant effect size [WMD=−0.38, 95% CI (−0.63, −0.12), P=0.33].

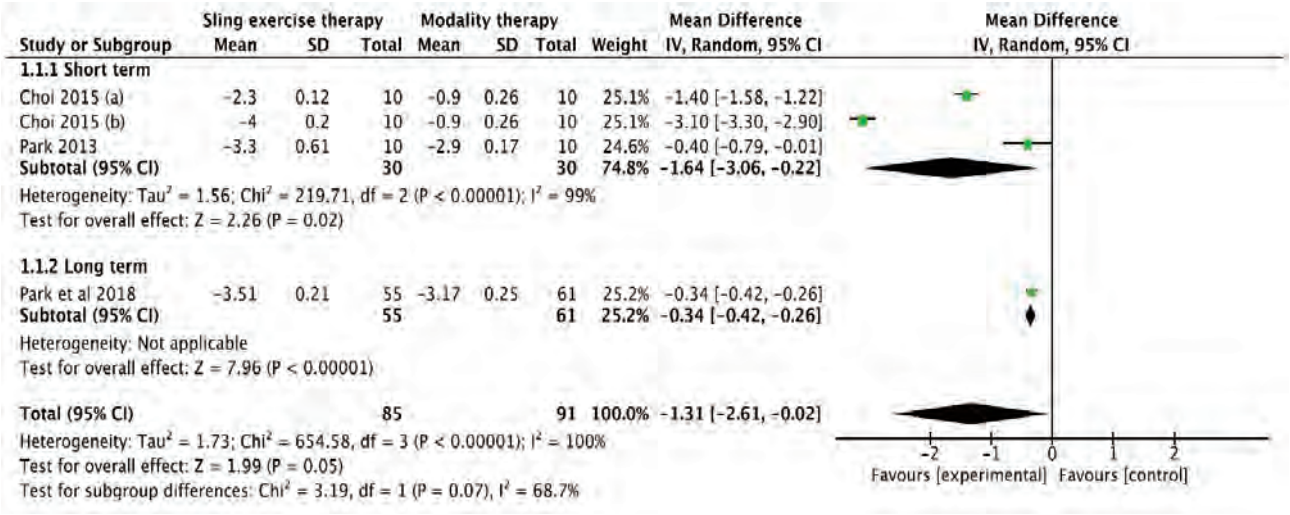
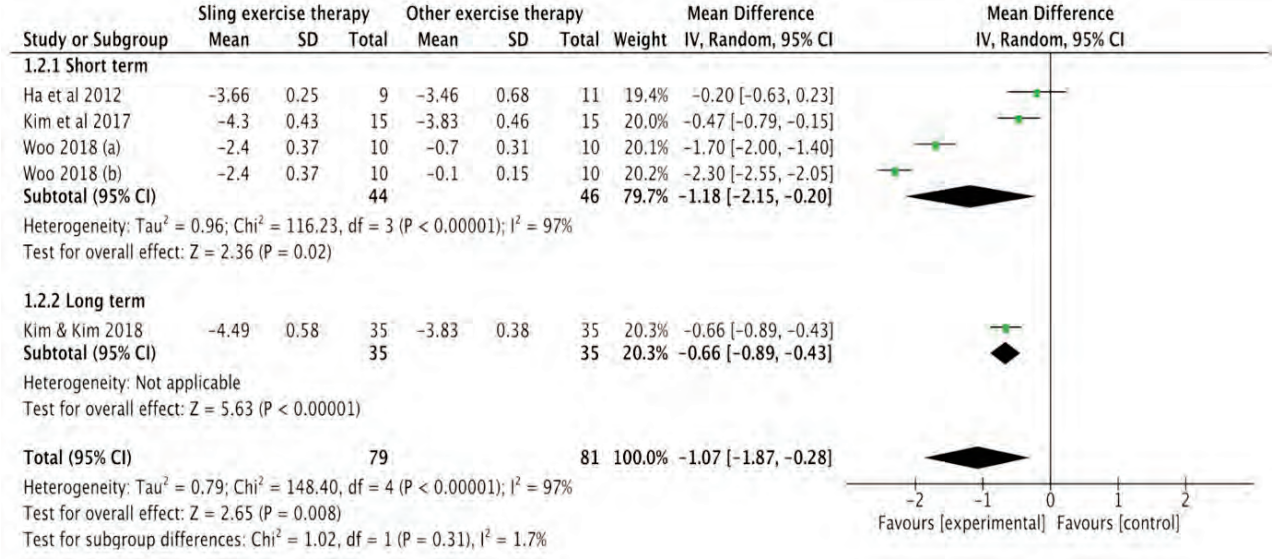


Figure 3. Forest plots for effect size comparison of SE and MT for pain



Comparison of SE and MT for disability

The studies comparing SE with MT revealed significant short-term [SMD=−15.82, 95% CI (−23.10, −8.54), P<0.00001] differences in disability (Figure 5). The heterogeneity for short-term disability was substantially high (I^2=93%). A meta-analysis excluding Choi 2015 (a) and (b) reduced heterogeneity (I^2=80%) and revealed a statistically significant effect size [SMD=−7.24, 95% CI (−10.61, −3.87), P=0.008].

Comparison of SE and OE for disability

The studies comparing SE with OE revealed non-significant short-term [WMD=−2.96, 95% CI (−3.71, −2.20), P=0.06] differences in disability (Figure 6). The heterogeneity for short-term disability was substantially high (I^2=60%). A meta-analysis excluding Woo 2018 (a) and (b) reduced heterogeneity (I^2=0%) and revealed a statistically non-significant effect size [WMD=−2.18, 95% CI (−3.01, −1.35), P=0.84].

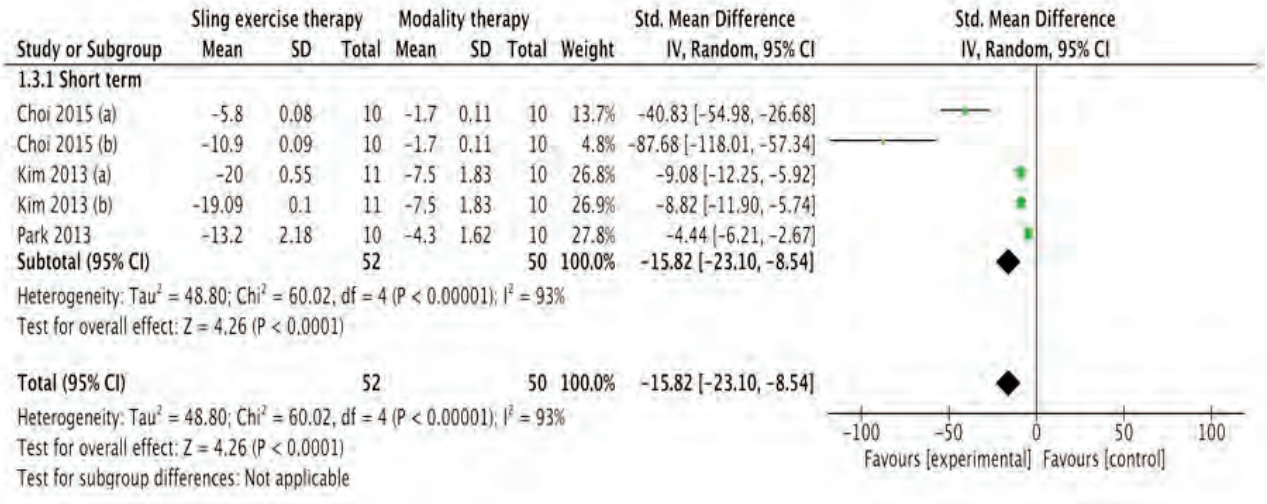


Figure 5. Forest plots for effect size comparison of SE and MT for disability

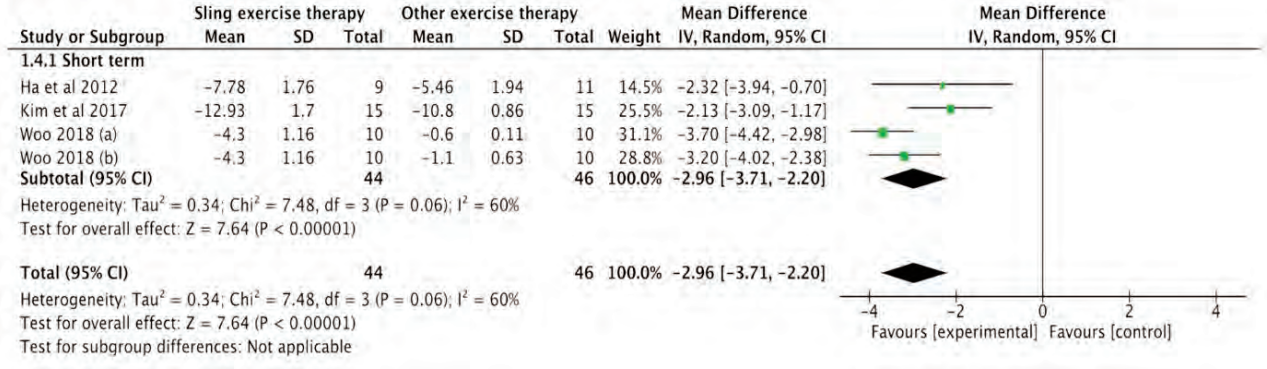


Figure 6. Forest plots for effect size comparison of SE and OE for disability

DISCUSSION

In this study, the effect of SE was compared to MT and OE and analyzed based on prior studies of CLBP patients published in Korea from the earliest searchable date to June 2020.

Comparing and analyzing SE and MT or OE for pain, the overall average effect size for SE was high effect size (MT: −1.31, OE: −1.07). This is consistent with the result that pain is less with SE than MT and OE when SE is applied to CLBP patients.[33] SE provides an unstable support surface, it is thought to reduce pain by inducing co-contraction of muscles and providing lumbar-pelvic stability.[34] Therefore, SE is thought to be more effective in reducing pain than MT and OE.

Comparing and analyzing SE and MT for disability, the overall average effect size for SE was high effect size (MT: −15.82). This is the result of recovering from dysfunction more with SE than MT when SE is applied to CLBP patients. It is thought that it had a positive effect on disability recovery by promoting neuromuscular activation during SE and smoothing the coordination ability of trunk muscles.[35]

In this study, no difference was found as a result of comparing the effect size of SE and OE on disability. This is consistent with the study results that exercise therapy is more effective in recovering from dysfunction than MT.[14,15] This is consistent with the result that there is no difference from OE when SE is applied to CLBP patients.[33] ODI evaluation items included the degree of pain. It has been reported that exercise therapy as well as SE improved pain, so it seems to have affected the ODI evaluation as the pain decreased.

As a result of analyzing a study published in Korea, SE was effective in improving pain and disability. The results of this study could be used as evidence for the use of se in the treatment of CLBP patients in hospitals in Korea.

An additional search was conducted on August 30 at the final stage of the study. Six studies were found at the last re-search of the study. However, the studies did not meet the criteria of this study.

There are some limitations in this study. The number of RCT studies was small. The small number of studies has several influences. It is difficult to generalize the effects of SE, and overall heterogeneity is high in this study. In order to perform an additional meta-regression analysis for the reason of high heterogeneity, at least 10 studies were required, so further analysis was limited. Because of the small number of studies, it was not evaluated for publication bias. Hand searching was not conducted in this study. Therefore, a wider range of research analysis and verification is required for SE by supplementing the limitations in this study, and further qualitative follow-up studies should be conducted continuously.

CONCLUSION

The results of this study showed that SE for CLBP patients had a positive effect on pain and disability. SE may contribute to the recovery of CLBP patients if it is applied in physical therapy to improve the main symptoms of CLBP patients. In addition, high-quality clinical research on SE should continue.

CONFLICT OF INTERESTS

No potential conflict of interest relevant to this article was reported

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APPENDIX

Search strategy : RISS, KISS, NDSL, DBpia, Earticle, scholar, and National Assembly Library
Koeran
#1 요통 AND 슬링
#2 요통 AND 슬링운동
#3 허리통증 AND 슬링
#4 허리통증 AND 슬링운동
English
#5 low back pain AND sling
#6 low back pain AND sling exercise