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PREVENTION & REHABILITATION: Randomized Controlled Trial

Immediate effects of thoracic spine self-mobilization in patients with mechanical neck pain: A randomized controlled trial

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A B S T R A C T

Objectives: To investigate the immediate effects of thoracic spine self-mobilization in patients with mechanical neck pain.
Study design: Randomized, controlled trial.
Background: Thoracic spine self-mobilization is performed after thoracic spine thrust manipulation to augment and maintain its effects. To the best of our knowledge, no study has investigated the effects of thoracic spine self-mobilization alone in individuals with mechanical neck pain. The purpose of this randomized, controlled trial was to evaluate the immediate effects of thoracic spine self-mobilization alone without any other intervention on disability, pain, and cervical range of motion in patients with mechanical neck pain.
Methods: Fifty-two patients (39 females and 13 males) with mechanical neck pain were randomly allocated to either a thoracic spine self-mobilization group that was performing a thoracic spine active flexion and extension activity using two tennis balls fixed by athletic tape or a placebo thoracic spine self-mobilization group. Outcome measures were collected at pre-intervention and immediately after intervention, including the Neck Disability Index, visual analogue scale, and active cervical range of motion (ROM). The immediate effect of the intervention was analyzed using two-way repeated measures analysis of variance (ANOVA). If interactions were found, a simple main effect test was performed to compare the pre-post intra-group results.
Results: The results of two-way repeated measures ANOVA indicated that the main effect of time was significant ($p < 0.05$) for all measurement outcomes. The main effect of group was not significant for all measurement outcomes ($p > 0.05$). The group × time interactions for cervical flexion active ROM ($p = 0.005$) and cervical extension active ROM ($p = 0.036$) were significant. The tests of simple main effect in cervical flexion active ROM ($p < 0.0001$) and cervical extension active ROM ($p < 0.0001$) showed a significant difference before and after intervention in the thoracic spine self-mobilization group.
Conclusion: Patients with mechanical neck pain who carried out thoracic spine self-mobilization showed increases in active cervical flexion and extension ROM.

1. Introduction

Neck pain is one of the most common musculoskeletal complaints in the general population. The lifetime prevalence of neck pain ranges from 14.2% to 71% (Fejer et al., 2006) and from 27.1% to 47.8% in workers (Haldeman et al., 2008). The one-year prevalence is about 37% in the adult population (Fejer et al., 2006), and from

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11% to 14.1% of workers are limited in their activities due to neck pain each year (Haldeman et al., 2008). In addition, in over 33% of neck pain patients, the pain becomes chronic (Pernold et al., 2005) and consequently causes reduction in activities of daily living, a financial burden, and decreased quality of life. Although any structure of the neck area that is innervated could become a potential source of neck pain, most neck pain is classified into mechanical neck pain, for which it is difficult to identify a specific pathoanatomic cause of pain (Childs et al., 2008). Although the definition varies in research studies, mechanical neck pain is most commonly defined as neck pain provoked by sustained neck postures, neck movement, or palpation of the cervical muscles (Fernández-de-Las-Peñas et al., 2007), excluding neck pain caused by a neurologic deficit, vascular deficit, neoplasm, or infection (van Schalkwyk et al., 2000; Aker et al., 1996).

Mechanical neck pain is generally treated conservatively with physical therapy including cervical mobilization and/or manipulation with exercises (Gross et al., 2004). In addition, clinical practice guidelines for the management of neck pain patients recommend the use of thoracic spine thrust manipulation (Childs et al., 2008). According to systematic reviews that examined the effects of thoracic spine thrust manipulation for mechanical neck pain, thoracic spine thrust manipulation may offer short-term improvement in pain, disability, and cervical range of motion in patients with mechanical neck pain (Cross et al., 2011; Young et al., 2014). A commonly used thoracic spine thrust manipulation technique has a supine thrust manipulation technique, which applies a high-velocity, low-amplitude thrust through the patient's arm toward the thoracic spine (Cross et al., 2011). Another commonly used thrust manipulation method is a seated thrust manipulation technique, which provides a distraction thrust in an upward direction to the thoracic spine (Cross et al., 2011). The effects of manipulation on the spinal column are suggested to include biomechanical effects, such as a change in range of motion (Lehman and McGill, 1999) and restoration of normal biomechanics (González-Iglesias et al., 2009), and a neurophysiological effect, such as an activation of descending inhibitory mechanisms (Vicenzino et al., 1996).

After undergoing thoracic spine thrust manipulation, patients with neck pain are often asked to perform thoracic spine self-mobilization, which improves the mobility of the thoracic spine and thorax, in order to reinforce and maintain the therapeutic effect of the thoracic spine thrust manipulation (Fernández-de-Las-Peñas et al., 2011). Self-mobilization of the thoracic spine involves not only active movement of the thoracic spine, but also using an exercise ball, foam roll, or tennis balls for the purposes of coping with excessive thoracic kyphosis and restoring a normal upright posture (Liebenson, 2001b; Johnson and Grindstaff, 2012).

Thoracic spine self-mobilization is also prescribed as a form of home exercise, since patients who have undergone thoracic spine thrust manipulation can carry out exercises with active movements of the thoracic spine more easily (Fernández-de-Las-Peñas et al., 2011). In addition, thoracic spine self-mobilization is performed to improve posture and thoracic spine ROM in athletes who experience neck pain (Durall et al., 2012). As described here, thoracic spine self-mobilization is commonly used to manage patients with neck pain. However, to the best of our knowledge, no previous studies have investigated the effect of thoracic spine self-mobilization alone for mechanical neck pain patients. In other words, there is evidence for passive intervention to the thoracic spine, such as thrust manipulation for neck pain patients, but the effect of active intervention to the thoracic spine (thoracic spine self-mobilization) for neck pain patients remains unknown, even though the self-mobilization is performed routinely.

It is unknown whether thoracic spine self-mobilization, a type of active movement of the thoracic spine, alone can have effects such as reducing pain or improving ROM in patients with neck pain. By identifying such effects, it may become possible to prescribe thoracic spine self-mobilization as a treatment or home exercise that is more specific to the patient's problems. The purpose of this randomized, controlled trial was to evaluate the immediate effects of thoracic spine self-mobilization alone without any other intervention on disability, pain, and cervical active range of motion in patients with mechanical neck pain.

2. Methods

2.1. Study design

This was a double-blind, randomized, controlled trial with two parallel arms and a 1:1 allocation ratio. One arm performed thoracic spine self-mobilization, and the other arm performed a placebo thoracic spine self-mobilization. The protocol for the study was approved by the Ethical Review Board of Tokyo Metropolitan University, Tokyo, Japan, and was conducted according to the Helsinki Declaration. In addition, this trial was registered through the University Hospital Medical Information Network Clinical Trial Registry (registration no. UMIN000017649) before the first patient was enrolled.

2.2. Participants

Consecutive outpatients with mechanical neck pain who were recruited from a rehabilitation department of an orthopedic clinic in Tokyo between June 2015 and December 2016 were screened for eligibility. Mechanical neck pain was defined as pain in the anatomic region between the superior nuchal line and an imaginary transverse line through the tip of the first thoracic spinous process (Bogduk and McGuirk, 2006), which was provoked by sustained neck postures, neck movement, or palpation of the cervical muscles (Fernández-de-Las-Peñas et al., 2007).

Inclusion criteria included: (a) age 20 years or older; (b) mechanical neck pain; and (c) a Japanese version of the Neck Disability Index (NDI) score of 15% or greater (7.5 points or greater on a 0-to-50 point scale). Exclusion criteria included: (a) history of a whiplash injury within 2 months; (b) severe thoracic kyphosis; (c) myelopathy; (d) severe cervical radiculopathy; (e) vertebral fracture; (f) history of neck and thoracic surgery; (g) cancer; (h) infection; (i) rheumatism; (j) ankylosing spondylitis; or (k) cognitive disorder. All patients provided their written, informed consent before participation in the study.

2.3. Outcome measures

The primary outcome measure in this trial was the NDI, which is used to assess the level of disability in neck pain patients. The NDI is a condition-specific, self-administered questionnaire that contains 10 items: pain intensity, personal care, lifting, reading, headache, concentration, work, driving, sleeping, and recreation. Each item is scored from 0 to 5, and the total score varies from 0 (no disability) to 50 (totally disabled) (Vernon and Mior, 1991). The total score is then converted to a percentage of disability in this study. The psychometric properties of the Japanese version of the NDI have been well documented. The intraclass correlation coefficient for test-retest reliability of the NDI was 0.91, and the minimal detectable change (MDC) was 6.8 points (13.6%) on the 0-to-50 point scale (Nakamaru et al., 2012).

Secondary outcome measures included a visual analogue scale (VAS) and active range of motion (ROM) of the cervical spine. The VAS was used to measure the intensity of resting neck pain. It was a 100-mm line with no pain at one end and the worst pain imaginable at the opposite end. Patients placed a mark along the line corresponding to the intensity of their symptoms. The VAS has been found to be a reliable and valid instrument for measuring acute and chronic pain levels (Bijur et al., 2001; Price et al., 1983). Cervical active ROM was measured using a universal goniometer having a full-circle plastic body that has been shown to be reliable, with intra-rater reliability ranging from 0.83 to 0.98 (Farooq et al., 2016). The patients were asked to adopt their natural sitting upright posture in a chair with both feet resting on the floor, with the hips and knees positioned at 90° angles. Measurements were conducted in the following order: flexion, extension, right lateral flexion, left lateral flexion, right rotation, and left rotation. All outcome measures were collected before and immediately after interventions by four physical therapists, with 4–13 years of clinical experience, who were blind to the patients' group allocation. All four assessors confirmed the data collection procedure prior to the start of the trial and practiced the designated measurement method.

2.4. Randomization procedure and blinding

Prior to starting the trial, a collaborator not involved in data collection created a randomization list with stratified permuted block randomization (block size 4) by sex and age using a computer. An assistant staff member at the rehabilitation department who was not involved in the study was responsible for patient allocation as a third party, and a printed randomization list was stored in a lockable locker located in a room different from that in which evaluation and intervention were performed. During the study, the randomization list could not be viewed by anyone except for the above allocation personnel.

The allocation procedure was as follows: first, the physical therapist responsible for evaluation (hereinafter, evaluating physical therapist) conducted screening and measurement in a treatment space partitioned by a curtain. After obtaining consent from patients who met the eligibility criteria, the sex and age of the patient were communicated to the allocation personnel. The allocation personnel who received this information then communicated the symbol noted on the randomization list to a physical therapist responsible for intervention (18 years of clinical experience), who was a different person from the evaluating physical therapist (hereinafter, intervention physical therapist). This intervention physical therapist replaced the evaluating physical therapist and asked the patient to perform the allocated intervention under supervision. After intervention, the evaluating physical therapist replaced the intervention physical therapist for re-evaluation. Patients were instructed not to disclose the particular intervention procedure received to the evaluating therapist. In this trial, the patients, assessors, and data analyst were blinded to the allocation. The physical therapist in charge of interventions was blinded to the results of measurements.

2.5. Interventions

Both interventions (thoracic spine self-mobilization and placebo self-mobilization) were done under the supervision of a physical therapist trained in the intervention procedure.

2.5.1. Thoracic spine self-mobilization

The patients crossed their arms over the chest and sat down on a backless chair with their back against a wall. A physical therapist in charge of intervention put the apparatus involving two tennis balls fixed by athletic tape (Fig. 1) between the patient's first and fourth thoracic spinous processes (Johnson and Grindstaff, 2012). The patient was asked to perform thoracic spine flexion to the end range in 3 s, and then thoracic spine extension to the end range in 3 s. After ten repetitions of the thoracic spine active flexion-extension movement, the apparatus was placed between the fifth and eighth thoracic spine spinous processes, and the same movements were repeated 10 times (Fig. 2-A, 2-B).

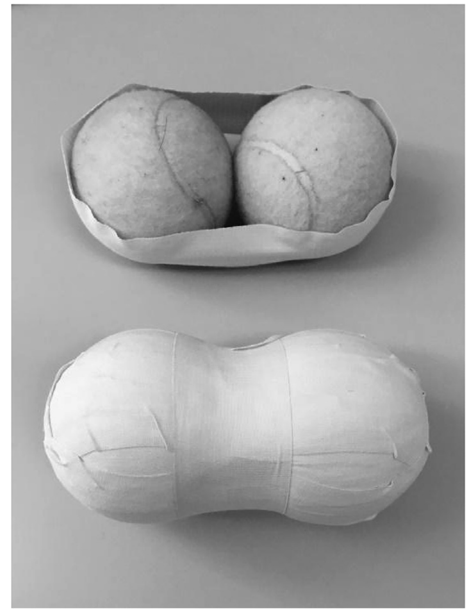

Fig. 1. The thoracic spine self-mobilization tool made by two tennis balls fixed by athletic tape.

2.5.2. Placebo thoracic spine self-mobilization

The patients took the same starting position as for thoracic spine self-mobilization, and they were asked to perform trunk anterior and posterior tilt by hip flexion and extension without spinal movement, taking 3 s for each direction (Fig. 3-A, 3-B). This active trunk anterior and posterior tilt movement was done 10 times for two sets.

2.6. Sample size determination

Sample-size estimation calculation was performed using G*Power 3.1.9.2 (Heinrich Heine University, Dusseldorf, Germany), taking into account a 2-tailed test, a large effect size ($d = 0.80$), an alpha value of 0.05, and 80% power. This generated a sample size of 26 patients per group.

2.7. Statistical analysis

Baseline demographic and clinical variables were compared between two groups using independent *t*-tests and chi-squared tests. The immediate effect of the intervention (thoracic spine self-mobilization or placebo self-mobilization) was analyzed using two-way repeated measures analysis of variance (ANOVA). If the interaction effects were significant, a simple main effects test was carried out as a post hoc analysis. The Cohen d coefficient was used to determine effect size between groups (Cohen, 1998). Effect size was interpreted as follows: $d = 0.20$ (small), $d = 0.50$ (medium), $d = 0.80$ (large) (Cohen, 1998). All data analyses were performed with IBM SPSS Statistics Version 22.0 (IBM Corporation, Armonk, NY). The level of significance was set at 0.05.

Fig. 2. Thoracic spine self-mobilization. Thoracic spine flexion (A), and thoracic spine extension (B).

Fig. 3. Placebo thoracic spine self-mobilization. Trunk anterior tilt (A), and trunk posterior tilt (B).

3. Results

Sixty-eight neck pain patients were screened for the study, and 16 patients were excluded; 14 patients met the exclusion criteria, and 2 patients refused to participate in the study. Thus, 52 patients (39 females and 13 males) were randomly allocated to the thoracic spine self-mobilization group ($n = 25$) or the placebo thoracic spine self-mobilization group ($n = 27$) (Fig. 4). No significant difference was found between the two groups for any demographic variables and baseline measures ($p > 0.05$), as shown in Table 1. None of the 52 patients reported any side effects from the interventions.

The results of two-way repeated measures ANOVA indicated that the main effect of time was significant ($p < 0.05$) for all measurement outcomes, and the group × time interactions, which show the difference in improvement between the groups, for cervical flexion active ROM ($F = 8.534$, $p = 0.005$) and extension active ROM ($F = 4.662$, $p = 0.036$) were significant. Conversely, the main effect of group was not significant for all measurement outcomes ($p > 0.05$) (Table 2).

The tests of simple main effect in cervical flexion active ROM (6° [95% CI: 3.7°, 8.3°], $p < 0.0001$) and extension active ROM (5.8° [95% CI: 3.0°, 8.6°], $p < 0.0001$) showed significant differences before and after intervention in the thoracic spine self-mobilization group (Table 3). The between-group effect size of cervical flexion active ROM was large ($d = 0.81$), and that of extension active ROM was medium ($d = 0.55$).

4. Discussion

The purpose of this randomized, controlled trial was to investigate whether intervention with thoracic spine self-mobilization affects the outcome in patients with mechanical neck pain. The

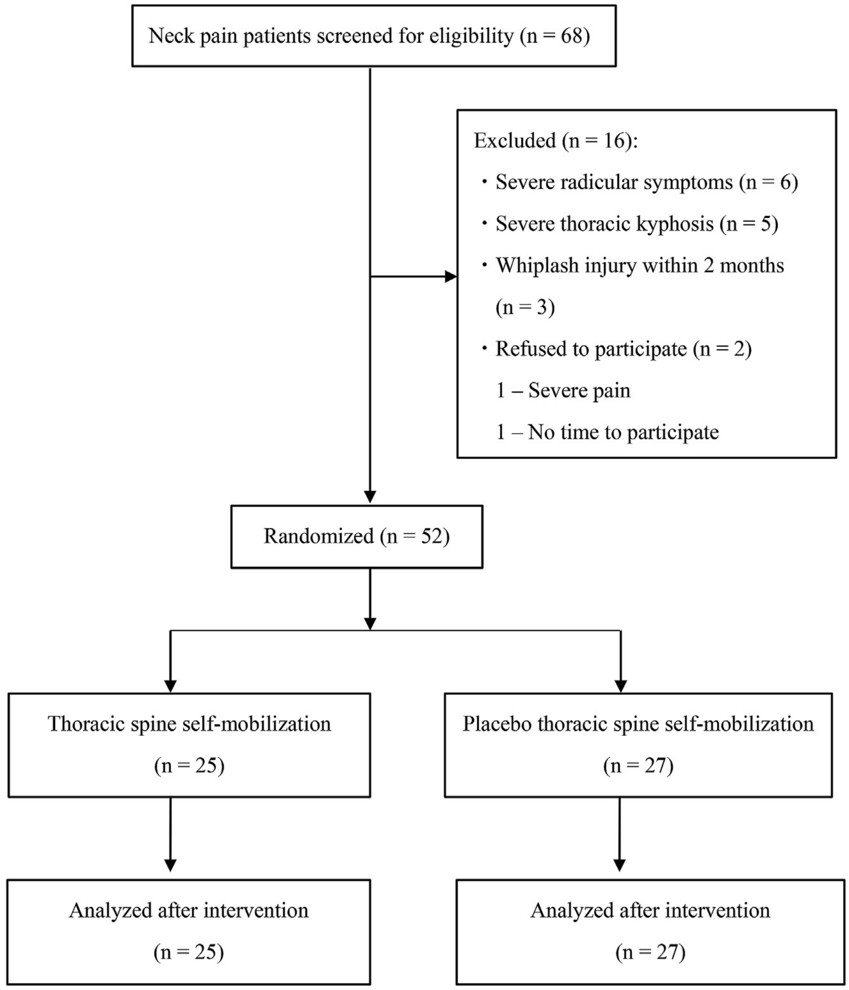

Fig. 4. Flow-diagram of subject selection and randomization.

Table 1
Baseline demographics and measurements of patients in both groups.

Variables	Self-mobilization group (n = 25)[b]	Placebo Group (n = 27)[b]	*P* Value
Sex (male/female) [c]	6/19	7/20	.873
Age (y)[a]	57 ± 15	62 ± 14	.289
Duration of symptoms (w)[a]	73.2 ± 154.8	46.3 ± 94.5	.450
Neck Disability Index (%)[a]	25.1 ± 8.4	29.4 ± 11.2	.124
Visual Analogue Scale (mm)[a]	38.0 ± 21.2	39.8 ± 24.1	.780
Cervical range of motion (°) [a]			
Flexion	49.7 ± 11.2	48.3 ± 10.4	.635
Extension	34.8 ± 12.9	39.2 ± 13.4	.239
Right lateral flexion	25.4 ± 7.9	23.9 ± 7.1	.483
Left lateral flexion	24.9 ± 8.5	23.9 ± 8.4	.663
Right rotation	55.6 ± 11.3	51.4 ± 11.5	.187
Left rotation	57.3 ± 10.2	55.4 ± 11.2	.524

[a] As determined by independent *t*-test.
[b] Values are mean ± SD except for sex.
[c] As determined by chi-squared test.

study results showed that active ROM in cervical spine flexion and extension improved significantly more in patients with neck pain who carried out thoracic spine self-mobilization than in those who performed placebo thoracic spine self-mobilization. Through these findings, we gained new insight into the effect of the thoracic spine self-mobilization performed in this trial on immediately improving active ROM in cervical spine flexion and extension.

Commonly used thoracic spine self-mobilization techniques include trunk extension active range of motion exercise in the prone position and using a foam roll in the supine position (Liebenson 2001b, 2007). These methods are suitable for improving mid-thoracic spine kyphosis. The reason that thoracic spine self-mobilization using two tennis balls was adopted in the present study was to improve restricted upper thoracic spine and mid-thoracic spine kyphosis, which is often found in patients with musculoskeletal disorders including mechanical neck pain

Table 2
Pre-intervention and post-intervention NDI, VAS, and cervical range of motion.

Variable	Thoracic self-mobilization (n = 25)[a]		Placebo self-mobilization (n = 27)[a]		Main effect: Group (*p*)	Main effect: Time (*p*)	Interaction (*p*)
	Pre	Post	Pre	Post			
NDI (%)	25.1 ± 8.4	20.0 ± 9.3	29.4 ± 11.2	25.7 ± 13.6	0.091	<0.0001	0.453
VAS (mm)	38.0 ± 21.2	32.5 ± 22.6	39.8 ± 24.1	36.5 ± 25.5	0.601	<0.0001	0.142
Active cervical range of motion (°)							
Flexion	49.7 ± 11.2	55.8 ± 12.6	48.4 ± 10.4	49.6 ± 11.3	0.219	<0.0001	0.005
Extension	34.8 ± 12.9	40.7 ± 11.0	39.2 ± 13.4	40.8 ± 14.9	0.527	<0.0001	0.036
Right LF	25.4 ± 7.9	28.4 ± 9.0	23.9 ± 7.1	25.2 ± 7.1	0.256	0.002	0.181
Left LF	24.9 ± 8.5	28.4 ± 8.4	23.9 ± 8.4	26.1 ± 9.6	0.477	<0.0001	0.327
Right ROT	55.6 ± 11.3	60.4 ± 9.5	51.4 ± 11.5	54.0 ± 11.4	0.077	<0.0001	0.160
Left ROT	57.3 ± 10.2	59.7 ± 9.2	55.4 ± 11.2	57.2 ± 10.0	0.429	0.001	0.625

NDI = Neck Disability Index, VAS = Visual Analogue Scale, LF = lateral flexion, ROT = rotation.
[a] Values are expressed as means ± SD for pre-intervention and immediate post-intervention data.

Table 3
Simple main effects test.

Measures	Within-Group Change Scores[a]	*P* value
Cervical flexion (°)		
Thoracic spine self-mobilization	6.0 (3.7, 8.3)	<0.0001
Placebo self-mobilization	1.1 (−1.0, 3.5)	0.268
Cervical extension (°)		
Thoracic spine self-mobilization	5.8 (3.0, 8.6)	<0.0001
Placebo self-mobilization	1.6 (−1.1, 4.3)	0.244

[a] Values are expressed as means (95% confidence interval) for within-group change scores.

(Norlander et al., 1996; Liebenson, 2001a). Self-mobilization using the two tennis balls might be suitable for mobilizing the targeted specific segments of the thoracic spine. Another reason for adopting this self-mobilization method was that the subjects may have included elderly people. For elderly subjects, taking the exercise position for self-mobilization in the prone position might itself be difficult, and when performing self-mobilization using a foam roll in the supine position, the patient might have difficulty controlling the pressure applied to the thoracic spine. Since the method used in this study was performed in the sitting position, it would be safe and easy even for elderly subjects. On the other hand, with this method there is the possibility that the range of thoracic spine motion becomes relatively small compared with other thoracic spine self-mobilization methods.

The present study results showed improvements in the VAS, which measured the extent of pain at rest, and in the NDI score, which measures disability after the intervention. However, there were no significant differences between the types of intervention. Previous studies that examined the effects of thoracic spine thrust manipulation in patients with neck pain showed that improvements in VAS and NDI exceeded the minimal clinically important difference and the minimal detectable change (Cleland et al 2005, 2007). Some of the presumed effects of thoracic spine thrust manipulation include neurophysiological effects, such as the activation of descending inhibitory pathways, as well as biomechanical effects such as the reduction of mechanical stress through the recovery of normal biomechanics (Vicenzino et al., 1996; Cleland et al., 2005; González-Iglesias et al., 2009). The results of this study did not show a difference between the groups in the improvement of the VAS or NDI, and only the ROM in cervical spine flexion and extension was significantly improved in the thoracic spine self-mobilization group. It can be postulated from these results that the effect of thoracic spine self-mobilization, an active movement of the thoracic spine, primarily consists of biomechanical effects, such as the improvement of joint ROM and normalization of joint function. Neurophysiological effects, such as pain suppression, appear to be less prominent than such effects observed after passive thrust manipulation.

In addition, the VAS and NDI score may have improved in the placebo group because the patient's posture improved through active movements that consisted of tilting the trunk in the anterior and posterior directions for placebo thoracic spine self-mobilization. In this placebo exercise, abdominal muscles and erector spinae muscles contract in order to stabilize and immobilize the spinal column, and the muscles surrounding the hip contract in order to tilt the trunk in the anterior and posterior directions. The posture of the spinal column and pelvis had improved through these effects of muscle contraction, thereby reducing mechanical stress to the cervical spine, and this may have led to the reduction in pain. There is evidence that thoracic spine thrust manipulation is effective for reducing pain and disability and increasing range of motion in patients with neck pain (Blanpied et al., 2017), but, on the other hand, there is insufficient evidence that thoracic spine thrust manipulation is more effective than placebo and control interventions in relieving pain and disability in patients with neck pain (Huisman et al., 2013). Bialosky et al. (2009) suggested that the effectiveness of spinal manipulation could be pain inhibition and changes in motoneuron pool activity, although non-specific effects due to placebo and patient expectations could not be ruled out. Since it has been found that the effect of placebo was significant in the intervention effect (Schiller L et al., 2001), the possibility that there was no difference between the groups in pain and disability due to the placebo effect could not be excluded in the present study.

In the present study, the improvement in ROM was 6.0° for cervical spine flexion and 5.8° for extension after the thoracic spine self-mobilization intervention. The effect size was large for active ROM in cervical spine flexion ($d = 0.81$) and medium for active ROM in cervical spine extension ($d = 0.55$). Previous studies that examined the immediate effects of thoracic spine thrust manipulation alone without combining with other treatment methods in patients with mechanical neck pain reported that cervical spine flexion improved 2.9–6.6° and cervical spine extension improved 3.2–10.2° after intervention (Casanova-Méndez et al., 2014; Suvamnato et al., 2013; Martínez-Segura et al., 2012). Based on this, it was suggested that intervention by thoracic spine self-mobilization (active movements) in patients with mechanical neck pain produces an effect similar to that of passive intervention with thoracic spine thrust manipulation in improving the ROM in cervical spine flexion.

The ROM in cervical spine flexion and extension alone improved significantly with the thoracic spine self-mobilization used in this trial, and a plausible reason for this is that the thoracic spine plays an essential role in normal mobility of the cervical spine (Crawford & Jull GA, 1993; Stewart et al., 1995), and the thoracic spine has a greater involvement during cervical spine movements in flexion and extension than in rotation and lateral flexion (Tsang et al., 2013). Moreover, since it is known that decreased thoracic spine mobility poses a risk for the onset of neck pain (Norlander et al., 1996), the improvement in thoracic spine mobility through thoracic spine self-mobilization may have increased the involvement of the thoracic spine during active cervical spine flexion and extension. In addition, one of the features of patients with neck pain is decreased angular velocity and angular acceleration of the upper thoracic spine during flexion and extension of the cervical spine (Tsang et al., 2013b). This is considered to be due to the development of problems with movement coordination and motor control originating from neck pain (Tsang et al., 2013b). By performing thoracic spine self-mobilization (active movement) and compressing the thoracic spine with the tool used in this study, the proprioceptors of muscles attached from the thoracic spine to the cervical spine can be stimulated, normalizing the muscle and joint functions and improving coordination and motor control during cervical spine movement. This may have consequently increased the ROM in cervical spine flexion and extension. Prior studies have shown that restricted ROM, primarily in cervical spine flexion and extension, is observed in patients with neck pain, as well as those who are currently asymptomatic but have a history of neck pain (Dall'Alba et al., 2001; Hagen et al., 1997; Lee et al., 2004). Thoracic spine self-mobilization improves the ROM of cervical spine flexion and extension, which is likely to become restricted in patients with neck pain, and it therefore appears to be one of the useful treatment methods in these patients.

There are several limitations to this study. First, only the immediate effects of thoracic spine self-mobilization were investigated in patients with mechanical neck pain. Future studies need to examine the effects of this self-mobilization over a long period. Second, this study did not assess changes of patients' thoracic spine mobility and posture after the interventions. Proving that there are changes in posture and thoracic spine ROM, etc. after intervention would potentially aid in elucidating why thoracic spine self-mobilization affects the cervical spine. Finally, another limitation of this study is that the disease stage of patients with neck pain was not determined in detail. This study included patients with all disease stages, from acute to chronic. However, by specifying the disease stage in future studies, it may be possible to prescribe treatments and home exercises that are more specific to the disease stage.

5. Conclusion

Although significant improvement was not seen in the NDI, which was used to assess the level of disability, and the VAS, which was used to measure the intensity of resting pain, this randomized, controlled trial showed that intervention with thoracic spine self-mobilization in patients with mechanical neck pain has an immediate effect in improving active ROM of cervical spine flexion and extension. Because thoracic spine self-mobilization improves the ROM of cervical spine flexion and extension, which is likely to become restricted in patients with neck pain, it was suggested that it can be prescribed as an adjunct treatment for patients with mechanical neck pain.

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