

The Effect of Thoracic Joint Mobilization and Self-stretching Exercise on Pulmonary Functions of Patients with Chronic Neck Pain

PIL-NEO HWANGBO, MS, PT¹⁾, GAK HWANGBO, PhD, PT²⁾, JUNGSEO PARK, PhD, PT³⁾, SANGYONG LEE, PhD, PT^{3)*}

¹⁾ Department of Rehabilitation Science Graduate School, Daegu University, Republic of Korea

²⁾ Department of Physical Therapy, College of Rehabilitation Science, Daegu University, Republic of Korea

³⁾ Department of Physical Therapy, Youngdong University: 12 Youngdong-eup, Youngdong-gun, Chungbuk 370-701, Republic of Korea

Abstract. [Purpose] The objective of this study was to determine the effect of thoracic joint mobilization and self-stretching exercise on the pulmonary functions of patients with chronic neck pain. [Subjects] The present study was performed with 34 patients with chronic neck pain featuring thoracic kyphosis; we divided them into a thoracic joint mobilization group (TJMG, n = 11), self-stretching exercise group (SSEG, n = 11), and thoracic joint mobilization and self-stretching exercise group (TJMSSEG, n = 12). [Methods] Treatments and exercise were conducted three times a week for six weeks in TJMG, SSEG, and TJMSSEG; the subjects' pulmonary functions in terms of forced vital capacity (FVC), forced expiratory volume at one second (FEV1), and peak expiratory flow (PEF) were measured using CardioTouch equipment. [Results] Comparisons of the individuals within each of the TJMG, SSEG, and TJMSSEG showed that all of FVC, FEV1, and PEF increased significantly; Comparisons within each of the showed that FVC, FEV1, and PEF increased significantly. Among the study groups, FVC was significantly higher in TJMSSEG than in TJMG after six weeks; FEV1 was significantly higher in TJMSSEG than in TJMG and SSEG after four and six weeks; and PEF was significantly higher in TJMSSEG than in TJMG and SSEG after six weeks. [Conclusion] The study results indicate that thoracic joint mobilization and self-stretching exercise are effective interventions for increasing FVC, FEV1, and PEF among pulmonary functions.

Key words: Thoracic joint mobilization, Self-stretching exercise, Pulmonary function

(This article was submitted Apr. 18, 2014, and was accepted May 16, 2014)

INTRODUCTION

In modern society, as more people are sitting for longer periods and aging progresses, kyphosis in the thoracic vertebra has been increasing¹⁾; this results in rounded shoulders and a decrease in thoracic cavity and vital lung capacity²⁾. In addition, this slouched posture puts the upper and lower cervical spine into a relative tension state while forwardly inclining the lower part of the cervical spine³⁾. A sustained forward-bending posture in the cervical spine could increase the load around the tissues near the neck⁴⁾, as well as the activities of muscles near the neck; additionally, the load increase in the assistant muscles and joints becomes a main cause of chronic pain near the neck and shoulder areas⁵⁾.

Many studies have sought to determine various causes of chronic neck pain, and to present therapeutic approaches

from various aspects; the results of studies on what constitutes the best therapeutic approach to chronic neck pain, however, have been divergent⁶⁾. Among the studies, one study reported that abnormal movement of the thoracic vertebra is a fundamental cause of cervical disorder in terms of the biomechanical correlation between the cervical spine and thoracic vertebra⁷⁾. Another study reported that not only direct joint mobilization of the cervical spine but also improvement of movement in the upper thoracic vertebra can increase the range of motion and reduce pain in the cervical spine⁸⁾. The most effective joint exercise therapy for increasing mobility in the thoracic vertebra is thoracic joint mobilization, which extends the joint in a direction in which movement is restrained⁹⁾. A self-stretching exercise can not only increase the flexibility of muscles in the joints but can also reduce muscle tension and increase blood circulation¹⁰⁾.

Although many previous studies have sought to determine the effect of thoracic joint mobilization and self-stretching exercise on pain and range of joint motion, previous studies have not addressed their effects on pulmonary functions. The aim of the current study was to determine the effect of such treatment and exercise on the pulmonary

*Corresponding author. Sangyong Lee (E-mail: lsy8275@hanmail.net)

functions of patients with chronic neck pain and thoracic kyphosis.

SUBJECTS AND METHODS

The subjects of this study were 34 patients with chronic neck pain during spinal flexion who visited Hospital N located in Daegu Metropolitan City, South Korea. Age, height, and weight in the TJM group (TJMG; 7 males and 4 females) were on average, 55.6±1.1 years, 164.5±2.6 cm, and 63.6±3.5 kg. In the SSE group (SSEG; 5 males and 6 females), they were 53.0±0.8 years, 166.8±2.8 cm, and 166.8±2.8 kg. Finally, in the TJMSSE group (TJMSSEG; 5 males and 7 females), they were 54.4±0.6 years, 167.3±2.3 cm, 65.0±3.5 kg. The subjects were randomly and equally assigned to the three groups. Prior to the experiment, all the subjects listened to an explanation of the study's purpose and exercise methods and provided written consent. Ethical approval for the study was granted by the Youngdong University institutional review board. Those who had been diagnosed with neurological findings and undergone operations or who were receiving surgical treatment or taking medicines on a regular basis to relieve pain were excluded from the study. We selected those with a spinal angle of 45 degrees or higher when measured in a standing position using a spinal mouse and a "minor disability" with a neck disability index ranging from 5 to 14 points.

During a six-week period, the subjects were treated three times a week. TJMG performed TJM for 15 min, SSEG performed SSEs for 15 min, and TJMSSEG conducted TJM for 15 min and SSEs for 15 min. All three groups also received conservative physical therapy. TJMG first performed thoracic flexion mobilization. Each subject was instructed to sit on a therapeutic chair, cross his/her arms, and place them in the transverse in the jointed part of the cervical vertebrae behind the neck.

The therapist stood to the left of the subject and fixed his/her vertebrae to the spinal segments intended to be treated. Using his/her hands, the therapist then adjusted the back support of the therapeutic chair or a wedge placed between the subjects and chair (Original Kaltenborn Concept Wedge, Allgummi GmbH & Co, Germany). The therapist then wrapped the subject's crossed elbows with his/her hands and flexed the subject's trunk slowly while pressing both elbows in the rear lower direction of the back support. During this process, the therapist used his/her hand to check the amount of spinal movement and potential movement of the vertebrae. Next, thoracic extension mobilization was performed. The therapist and the subject maintained the same posture as that of thoracic flexion mobilization. After wrapping the subject's crossed elbows with a hand, the therapist slowly stretched the subject's trunk backward by pressing both elbows in the rear upper direction of the back support. Finally, the separation technique of thoracic facet joint distraction mobilization was then employed. The subject lay face down on a treatment table. The therapist then selected the segments with less movement among the spinal auricular surfaces using a wedge and placed across the wedge crossways the selected vertebrae. The therapist

grabbed the wedge with both hands and exerted a force for joint traction using his/her weight.

SSEG conducted SSEs on the major and minor pectorals. First, the subject sat on a chair with his/her back straightened and pulled in his/her jaw. The subject held a long belt with both hands and spread it wider than the distance between the shoulders. While bending the shoulders at 180°, the subject flexed the shoulders excessively, as if stretching. After maintaining this position for 10 sec, the subject returned to the original position. Next, SSEs of the upper trapezius were performed. While seated with a correct posture on the chair, the subject fixed the hand intended to be extended behind a sheet placed under the hip to depress the shoulder. After this, the subject adopted a cervical posture (flexion + side flexion + rotation; non-coupled motion) to extend the upper trapezius to the fullest and maintained this posture for 45 sec. Finally, the SSE was performed on the levator scapulae of the shoulder bone. In this exercise, the subject adopted the correct sitting posture on a chair and depressed the shoulders by fixing the hand intended to be extended behind the sheet under the hip. The subject then adopted a posture (flexion + side flexion + rotation couple motion) to extend the levator scapulae to the fullest and maintained it for 45 sec.

To measure pulmonary functions, a CardioTouch 3000s (Bionet; Seoul, South Korea) was used while the subjects remained seated. The forced vital capacity (FVC) and forced expiratory volume at one second (FEV1) were measured, while the peak expiratory flow (PEF) was measured to determine airway resistance. To reduce measurement error, in each case, the average of three measurements was used as the final result.

Repeated one-way ANOVA was employed for statistical processing to determine the pulmonary function within each group; one-way ANOVA, meanwhile, was conducted to compare the groups themselves. The Bonferroni correction method was used as a post hoc test. The current study used SPSS 12.0 for Windows for statistical processing, and the significance level α was set to 0.05.

RESULTS

Comparisons within each of the groups showed that FVC, FEV1, and PEF increased significantly ($p < 0.05$). Among the study groups, FVC was significantly higher in TJMSSEG than in TJMG after six weeks; FEV1 was significantly higher in TJMSSEG than in TJMG and SSEG after four and six weeks ($p < 0.05$); and PEF was significantly higher in TJMSSEG than in TJMG and SSEG after six weeks ($p < 0.05$) (Table 1).

DISCUSSION

This study conducted experiments three times a week for six weeks to identify the effects of TJM and SSEs on pulmonary function in patients with chronic neck pain. Jeong¹¹⁾ reported that the ROM in the jointed part of the neck and spine and chronic neck pain show a high correlation. In other words, if the ROM in the jointed part of the neck and spine increases, the VAS and neck disability index

Table 1. Variation of FVC, FEV1, and PEF between groups

	Group	Pre	2 weeks	4 weeks	6 weeks
FVC (L)	TJMG**	2.5±0.8 ^a	2.5±0.7	2.7±0.8	3.0±0.8
	SSEG**	2.6±0.6	2.6±0.6	2.8±0.6	3.1±0.7
	TJMSSEG**	2.8±0.9	3.1±0.8	3.5±0.9	3.8±0.8 [†]
FEV1 (L)	TJMG**	1.9±0.7	2.1±0.6	2.3±0.7	2.4±0.7
	SSEG**	1.8±0.6	2.0±0.5	2.2±0.5	2.4±0.7
	TJMSSEG**	2.3±0.6	2.6±0.7	3.0±0.8 [†]	3.3±0.8 [†]
PEF (LPS)	TJMG**	3.2±1.1	3.6±1.1	3.9±1.1	4.2±1.2
	SSEG**	3.2±1.3	3.5±1.2	4.0±1.3	4.2±1.3
	TJMSSEG**	3.5±1.2	4.2±1.1	4.9±1.1	5.6±1.3 [†]

^aMean±SD. FVC, forced vital capacity; FEV1, forced expiratory volume at one second; PEF, peak expiratory flow; TJMG, thoracic joint mobilization group; SSEG, self-stretching exercise group; TJMSSEG, thoracic joint mobilization and self-stretching exercise group. *Repeated one-way ANOVA [†]p<0.05 (one-way ANOVA). **: p<0.01.

also increase in patients with chronic neck pain. Cleland et al.¹² reported that manipulation of the upper vertebrae (C7 to T2) and middle vertebrae (T3 to T10) exercises resulted in a statistically significant decline in chronic neck pain. Sterling et al.¹³ reported that the VAS declined from 5.8 cm to 2.8 cm after applying the joint mobilization technique. Hurwitz et al.¹⁴ suggested that a three-week program of electrical therapy and joint mobilization was more effective than joint exercise in patients with subacute neck pain. Kim et al.¹⁵ noted that the range of motion of the upper spine was an effective intervention for dynamic stability among chronic neck pain patients

In active exercise therapies, extension is effective in increasing the ROM in soft tissues and the ROM in reduced narrow ROM structures¹⁶. Jung¹⁷ reported that an eight-week home-based cervical exercise program changes the curves in the right side. Omer et al.¹⁸ also asserted that mobilization and stretching relaxation techniques are effective for reducing and increasing the ROM of computer users who exhibit cervical and trapezius pain. Yang¹⁹ showed that application of thoracic vertebra extension exercises resulted in statistically significant increases in VAS, spinal length (C7 to S3), and flexibility of thoracic vertebra extension. Seo²⁰ found that male office workers who complained of cervical pain experienced a minor level of improvement after application of upper thoracic vertebra exercises, but this result was not statistically significant.

As mentioned, comparisons of the individuals within TJMG, SSEG, and TJMSSEG showed that FVC, FEV1, and PEF had increased significantly; Among the study groups, FVC was significantly higher in TJMSSEG than in TJMG after six weeks; FEV1 was significantly higher in TJMSSEG than in TJMG and SSEG after four and six weeks; and PEF was significantly higher in the TJMSSEG than in the TJMG and SSEG, after six weeks. Chronic neck pain patients with thoracic kyphosis develop round shoulders that stem from increased thoracic kyphosis; this triggers decreases in vital capacity and thoracic cavity capacity. This is because thoracic joint mobilization or self-stretching exercises for the spine improve limited movements of the spine, recover facet joint sliding, and normalize the articular capsule, thereby decreasing kyphosis and enhancing the

flexibility of thoracic extension. Therefore, it is considered that increased mobility of the thorax ameliorates pulmonary functions. In addition, pulmonary functions were better in TJMSSEG than in TJMG and SSEG after six weeks because the simultaneous performance of thoracic joint mobilization (a therapist's passive manual therapy) and self-stretching exercise (performed by patients themselves) was effective in recovering facet joint sliding of the spine and normalizing the articular capsule.

This study had some limitations. The main one is the limited number of subjects with chronic neck pain, resulting in difficulties generalizing the results. Furthermore, this study failed to measure range of motion of thoracic kyphosis and the flexibility of spinal extension. Future studies will be required to identify the effects of TJM and SSEs on the pulmonary functions of patients with stroke.

REFERENCES

- 1) Neumann DA: Kinesiology of the Musculoskeletal System: Foundations for Rehabilitation. Mosby, 2010.
- 2) Ko TS, Jung HB, Kim JA: The effects of thoracic mobilization on pain, disability index and spinal mobility in chronic low back pain patients. *J Special Edu Rehabil Sci*, 2009, 48, 2: 115-137.
- 3) Black KM, McClure P, Polansky M: The influence of different sitting positions on cervical and lumbar posture. *Spine*, 1996, 21: 65-70. [Medline] [CrossRef]
- 4) Gooch JL, Randle J: Force perception before and after maximal voluntary contraction. *Percept Mot Skills*, 1993, 76: 399-402. [Medline] [CrossRef]
- 5) Grace EG, Sarlani E, Reid B: The use of an oral exercise device in the treatment of muscular TMD. *Cranio*, 2002, 20: 204-208. [Medline]
- 6) Hudson JS, Ryan CG: Multimodal group rehabilitation compared to usual care for patients with chronic neck pain: a pilot study. *Man Ther*, 2010, 15: 552-556. [Medline] [CrossRef]
- 7) Vicenzino B, Collins D, Wright A: The initial effects of a cervical spine manipulative physiotherapy treatment on the pain and dysfunction of lateral epicondylalgia. *Pain*, 1996, 68: 69-74. [Medline] [CrossRef]
- 8) Krauss J, Creighton D, Ely JD, et al.: The immediate effects of upper thoracic translatoric spinal manipulation on cervical pain and range of motion: a randomized clinical trial. *J Manual Manip Ther*, 2008, 16: 93-99. [Medline] [CrossRef]
- 9) Kaltenborn FM: The Spinal Basic: Evaluation and Mobilization Techniques, 3rd ed. Minnesota: OPTP, 1993.
- 10) Park HS, Park TS: The comparison of stretching for prevention of shoulder disease in elders. *Korean J Phys Edu*, 2005, 44: 675-681.
- 11) Jeong UC: The effects of additional thoracic mobilization on neck pain patients; visual analog scale, neck disability index, and muscular endurance. Ulsan University, Dissertation of master's degree, 2009.
- 12) Cleland JA, Flynn TW, Childs JD, et al.: The audible pop from thoracic

- spine thrust manipulation and its relation to short-term outcomes in patients with neck pain. *J Manual Manip Ther*, 2007, 15: 143–154. [[Medline](#)] [[CrossRef](#)]
- 13) Sterling M, Jull G, Wright A: Cervical mobilisation: concurrent effects on pain, sympathetic nervous system activity and motor activity. *Man Ther*, 2001, 6: 72–81. [[Medline](#)] [[CrossRef](#)]
 - 14) Hurwitz EL, Aker PD, Adams AH, et al.: Manipulation and mobilization of the cervical spine. A systematic review of the literature. *Spine*, 1996, 21: 1746–1759, discussion 1759–1760. [[Medline](#)] [[CrossRef](#)]
 - 15) Kim G, Lee S, Jeong H: Effects of upper thoracic joint mobilization on dynamic stability of patients with chronic neck pain. *J Phys Ther Sci*, 2011, 23: 753–756. [[CrossRef](#)]
 - 16) Kisner C, Collby LA: *Therapeutic Exercise: Foundations and Techniques*, 4th ed. Philadelphia: F.A. Davis, 2002.
 - 17) Jung JY: The effects of home-exercise program on the pain, cervical range of motion, neck disability index and cervical spine curvature for patients with chronic neck pain. Ewha Wonams University. Dissertation of master's degree, 2005.
 - 18) Omer SR, Ozcan E, Karan A, et al.: Musculoskeletal system disorders in computer users: effectiveness of training and exercise programs. *J Back Musculoskeletal Rehabil*, 2004, 17: 9–13.
 - 19) Yang YA: A study on effects of thoracic spinal exercise program in VDT workers. Hanyang University. Dissertation of doctor's degree. 2003.
 - 20) Seo MH: A Study on the effects of automobilization on the decrease of chronic neck pain. Kyungpook National University, Dissertation of master's degree, 2012.