

# Effects of Upper Thoracic Joint Mobilization on Dynamic Stability of Patients with Chronic Neck Pain

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**Abstract.** [Purpose]The purpose of this study was to examine the effects of upper thoracic joint mobilization on the dynamic stability of patients with chronic neck pain. [Subjects]The subjects of this study were 37 patients diagnosed with chronic neck pain. They were divided into a group for joint mobilization after conservative physical therapy (JCPTG, n=19) and a self-stretching group after conservative physical therapy (SCPTG, n=18). [Methods] To see changes in dynamic stability, we analyzed and compared images using a picture archiving and communication system (PACS). [Results] Over the course of the treatment period, decreases in pendular movements (PM) and translational movements (TM) appeared between the JCPTG and SCPTG. Between the JCPTG and SCPTG, there were no significant differences in PM during flexion and extension and in TM during flexion before the treatment, although there were statistically significant differences at four weeks and eight weeks. There was no significant difference in TM of extension in any case. [Conclusion]We consider that upper thoracic joint mobilization is an effective intervention for the dynamic stability of patients with chronic neck pain.

**Key words:** Mobilization, Chronic neck pain, Dynamic stability

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## INTRODUCTION

Roughly 15% of males and 23% of females suffer from neck pain. Of these, approximately half complain of unceasingly persistent chronic neck pain<sup>1)</sup>, and the number of patients who complain of neck pain has been gradually increasing<sup>2,3)</sup>. Due to accidents or degenerative changes, excessive translational movements of the intervertebral disk within the joint between adjacent vertebral bodies occurs<sup>4)</sup>. Thoracic vertebrae are closely connected to the axial skeleton in order to be neurologically connected with the proximal and dorsal parts and the abdominal organs, thereby affecting the neck bones and lumbar vertebrae. This correlation between the thoracic vertebrae and the neck bones means that upper thoracic insufficiency eventually results in changes in the range of motion of the neck region, with headaches and pain appearing in the upper extremities<sup>5)</sup>. Two studies have indicated that pain in the cervical vertebrae is relieved and the range of motion is increased, not only by direct intervertebral joint mobilization, but also by improving upper thoracic movements<sup>1,6)</sup>.

Many previous studies have been conducted on neck

pain relief and increase of the range of motion through improvements in upper thoracic vertebral movements achieved by treatment with joint mobilization techniques. However, there have been few studies on dynamic stability evaluating the quality of movements. Accordingly, this respect, this study was conducted in order to provide basic data on changes in dynamic stability by comparing and analyzing upper thoracic joint mobilization and stretching exercises, with the aim of recovery of the quality of movement in patients with chronic neck pain.

## SUBJECTS AND METHODS

This study was conducted with 37 adults as subjects who ranged in age from 25 to 34 and had chronic neck pain persisting for at least the last three months based on diagnoses made at H Hospital located in D City, South Korea. The subjects were randomly selected and assigned to the a self-stretching and conservative physical therapy group (SCPTG) and a joint mobilization and conservative physical therapy group (JCPTG). Eighteen of the participants (seven males and eleven females) were in the SCPTG, for which conservative physiotherapy and self-

stretching exercise were combined; their mean age was  $30.3 \pm 1.1$  years, their mean height was  $167.9 \pm 2.3$  cm, and their mean weight was  $62.3 \pm 2.4$  kg. The JCPTG group, for which conservative physiotherapy and upper thoracic joint mobilization was prescribed, was comprised of 19 participants (eight males and eleven females); their mean age was  $30.5 \pm 0.9$  years, their mean height was  $168.6 \pm 2.4$  cm, and their mean weight was  $63.5 \pm 2.9$  kg. There were no statistically significant differences between the two groups ( $p > 0.05$ ), indicating the two groups were homogeneous.

Those who had neurological issues, histories of surgery, had been receiving surgical injection therapy or were periodically taking drugs to relieve pain, and those who were pregnant were excluded from the study. Those who participated in this study participated based on their voluntary agreement, given after receiving sufficient explanation about the purpose of the study and overall details about the experiment.

All of the patients were treated three times per week for eight weeks, and measurements were made three times in total, including before the experiment, and again at both four weeks after and eight weeks after the start of experiment. Conservative physiotherapy was performed for 45 minutes in each session, including 20 minutes of hyperthermia using hot packs, 15 minutes of interference current therapy at 100 bps, and 10 minutes of medical diathermy using ultrasonic waves applied to the painful areas.

In this study, the joint mobilization was performed by one orthopedic manual therapist who had at least 10 years clinical experience. The self-stretching therapy was conducted for the levator scapula muscle, the upper trapezius muscle, and the sternocleidomastoid muscle, where muscle tone increases the most in chronic neck pain. For self-stretching of the levator scapula muscle, the patient fixed the hand on the stretched side on the seat under the hip, in order to depress the shoulder while sitting upright on a chair, and placed the neck in a posture that could maximally stretch the levator scapula muscle (flexion + side flexion + rotation; couple motion) and maintained the posture for 45 seconds. For self-stretching of the upper trapezius muscle, the patient fixed the hand on the stretched side on the seat under the hip, in order to depress the shoulder while sitting upright on a chair, and placed the neck in a posture that could maximally stretch the upper trapezius muscle (flexion + side flexion + rotation; non-couple motion), and maintained the posture for 45 seconds. For self-stretching of the sternocleidomastoid muscle, the patient sat on a chair and supported the jaw with both hands, fixing their fingers on the chin toward their ears. The patient then pushed the head and neck backward, so that stretching was felt on the front side, before pushing the jaw toward the hands, while looking downward, for five seconds. The patient then pushed the head and neck backward as much as possible, and repeated the movement until the muscle could not be stretched any further. All of the self-stretching exercises were repeated three times in each round, for approximately 15 minutes.

For upper thoracic joint mobilization, the flexion mobilization was performed as follows: the therapist had the patient lock his fingers together, wrapped around the back of the neck, and sitting on a chair with his hip joint open at approximately  $30^\circ$  and his feet touching the floor. The therapist stood on the left side of the patient and maximally pushed his lower extremities toward the patient to stabilize the patient's hip bone, and supported the patient's elbow joint with one upper extremity. He also fixed the spinous process of the lower segment of the region to be flexed using the index and middle fingers of the fixing hand, and made the upper segment passively move in the cranial and ventral directions by applying force until immediately before the fixed segment moved.

The extension mobilization was performed as follows: in the same (patient's and therapist's) postures, the therapist lifted the patient's elbow joint up to extend the thoracic vertebrae, and pushed the spinous process forward to apply pressure in the opposite direction. The thoracic vertebral spinous process articular surface distraction was performed as follows: the patient adopted a prone position, and the therapist placed his index and middle fingers on the transverse processes on both sides, as with the thoracic vertebral spring test, and applied force from the dorsal to the ventral side. In the joint mobilization, upper thoracic segmental mobilization was performed for five minutes to increase flexion, five minutes for extension and for five minutes to distract the facet joint. The joint mobilization was performed for around 15 minutes in the session.

Dynamic stability was measured by taking images using a radiation imaging device (R-630-150, Dongkwang, Korea) and enlarging the images three times with a picture archiving and communication system (PACS) (Infinit, Korea). A plain radiologic examination was performed by taking images of the participants in the upright standing position, with their genital regions covered by protective equipment. Left lateral views of the neck region were taken, in order to see cervical movements. In the plain radiographs, the center points of the third through C7 vertebrae were determined as the points where two lines connecting the edges corresponding to each vertebral body met with each other. Pendular movements were measured by examining changes in distance between the center points of adjacent vertebral bodies, and indicating increases in the distances compared to the distances when the images were taken in the neutral position. Translational movement refers to movements along the horizontal axis that cause changes to the extended lines that connect the center point of the neck bones to the center point of the adjacent neck bones immediately below the center point of the neck bones. The shortest distance and the movement were recorded as negative numbers when the center point of the neck bones moved to the front side of the extended lines that connect the center point of the neck bones and the center point of the adjacent cervical vertebrae immediately below the center point of the cervical vertebrae. The shortest distance and the movement were recorded as positive numbers when the center point of the cervical vertebrae moved to the back side. The sizes of the momentum of the pendular and

translational movements of the cervical vertebrae were obtained by summing up the sizes of momentum in the states of passive movement in the neutral position, cervical flexion and cervical extension (Figures 1 and 2).

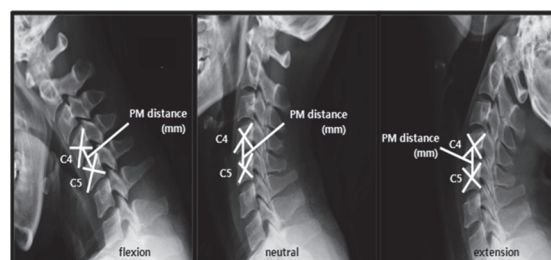
For statistical processing, repeated analysis of variance (ANOVA) was performed in order to examine the dynamic stability within each group. To examine significant differences between the groups, independent sample t-tests were conducted with changes between before the treatment, four weeks and eight weeks after the treatment. In this study, the SPSS 12.0 for Windows was used for statistical processing, and the significance level was chosen as 0.05.

## RESULTS

Based on the results of the dynamic stability examination, there were statistically significant differences over time in PM and TM during flexion and extension within the groups ( $p < 0.05$ ). Between the JCPTG and SCPTG, there were no significant differences in PM during flexion and extension and in TM during flexion before the treatment ( $p > 0.05$ ) although there were statistically significant differences at four weeks and eight weeks ( $p < 0.05$ ). However, there was no significant difference in TM during extension in any cases ( $p > 0.05$ ) (Table 1).

## DISCUSSION

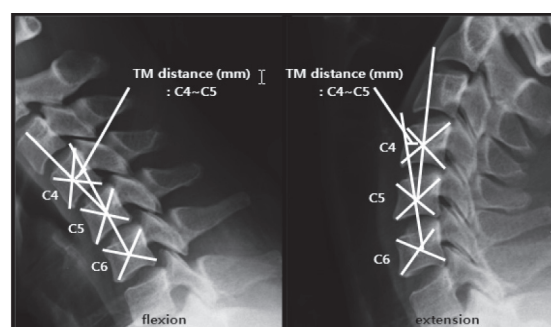
In this study, patients suffering from chronic neck pain received through upper thoracic joint mobilization or performed stretching exercises and we investigated the effects of upper thoracic joint mobilization and stretching exercises on changes in dynamic stability. When considered from the viewpoint of vertebral kinesiology, cervical movements include movements up to the upper thoracic vertebrae (T1–T4), and skilled clinicians include an examination of thoracic vertebrae for primary problems in the neck region<sup>7,8)</sup>. Many previous studies have performed direct therapeutic interventions in order to relieve neck pain and improve range of movement. Joshua et al. (2007) reported that upper thoracic joint mobilization had a significant effect in terms of neck disability indexes, cervical range of motion (ROM), and visual analog scales of pain<sup>9)</sup> in patients with chronic neck and shoulder joint pain. Studies by Cleland et al. (2007) and Krauss et al.



**Fig. 1.** Measurement method for pendular movement

(1) Distance of lower cervical flexion on PM (C3–C4 + C4–C5 + C5–C6 + C6–C7)

(2) Distance of lower cervical extension on PM (C3–C4 + C4–C5 + C5–C6 + C6–C7)



**Fig. 2.** Measurement method for translational movement

(1) Distance of lower cervical flexion on TM (C3–C4 + C4–C5 + C5–C6 + C6–C7)

(2) Distance of lower cervical extension on TM (C3–C4 + C4–C5 + C5–C6 + C6–C7)

(2007) reported that direct cervical mobilization and therapeutic interventions intended to improve upper thoracic movements were helpful in relieving neck pain and improving ROM<sup>1,6)</sup>.

In this study, there were statistically significant differences in the dynamic stability of pendular movements during flexion and extension over time within the JCPTG and SCPTG groups, and in pendular movements during flexion and extension, statistically significant differences appeared between the JCPTG and SCPTG after four weeks

**Table 1.** The comparison of PM and TM within groups. (unit: mm)

movement	Motion	Group	Pre	4 weeks	8 weeks
PM	Flexion	JCPTG*	79.33 ± 0.7	71.30 ± 0.7	69.22 ± 0.7
		SCPTG*	79.69 ± 0.5	77.41 ± 0.6	75.75 ± 0.6
	Extension	JCPTG*	78.97 ± 0.7	72.44 ± 0.9	69.97 ± 0.8
		SCPTG*	80.14 ± 0.6	77.77 ± 0.6	75.77 ± 0.6
TM	Flexion	JCPTG*	-5.00 ± 0.1	-4.60 ± 0.1	-4.33 ± 0.1
		SCPTG*	-5.30 ± 0.2	-5.06 ± 0.2	-4.82 ± 0.1
	Extension	JCPTG*	15.76 ± 0.2	15.10 ± 0.2	14.83 ± 0.2
		SCPTG*	15.87 ± 0.3	15.44 ± 0.3	15.07 ± 0.3

\*: repeated ANOVA. †: independent sample t-tests \*. †p < 0.05. PM, pendular movement; TM, translational movement; JCPTG, joint mobilization after conservative physical therapy group; SCPTG, self-stretching after conservative physical therapy group.

and eight weeks of treatment.

There were also statistically significant differences in the dynamic stability of translational movements during flexion and extension over time within JCPTG and SCPTG. Translational movements during flexion and extension and pendular movements during flexion showed statistically significant differences between the groups after four weeks and eight weeks of treatment, but translational movements during extension did not show any statistically significant differences. In this study, based on the results of the dynamic stability tests, the upper thoracic joint mobilization conducted for the JCPTG group had more significant effects on the stability of pendular movements than on translational movements. This means that the pathologic hypermotility appearing in initial degeneration decreased, indicating that stability in the joint was improved.

Although upper thoracic joint mobilization and self-stretching exercises are effective for relieving neck pain and improving ROM, the results of this study indicate that joint mobilization is more effective at improving dynamic stability, which controls the increase of pendular momentum appearing in initial degeneration, as seen from a biomechanical viewpoint. The hypermotility of the lower cervical vertebrae occurring due to upper thoracic insufficiency becomes an important cause of degeneration of intervertebral disks and intervertebral joints, due to friction and wear. When the path of the instantaneous center of rotation of joints is observed, it can be seen that, in the case of initial hypermotility, pendular movements increase in the joints rather than translational movements, and as

degeneration progresses, the momentum of translational movements increases. This unstable state will become an important cause of increasing wear on intervertebral disks. Therefore, upper thoracic joint mobilization can be said to be effective at controlling the hypermotility of the lower cervical vertebrae in the early stages of prevention of intervertebral joint degeneration.

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