J. Phys. Ther. Sci.
27: 795–798, 2015

Original Article

Changes in proprioception and pain in patients with neck pain after upper thoracic manipulation

Jinmo Yang[1)], Byoungkwon Lee[2)*], Changbeom Kim[1)]

[1)] *Department of Physical Therapy, The Graduate School, Daejon University, Republic of Korea*
[2)] *Deptartment of Physical Therapy, Konyang University: 28 Gasuwon-dong, WonangMaeul 1-gil, Seo-gu, Daejon 302-718, Republic of Korea*

Abstract. [Purpose] The purpose of this study was to conduct cervical stability training and upper thoracic manipulation for patients with chronic neck pain and then investigate the changes of cervical proprioception and pain. [Subjects and Methods] Subjects were 30 workers with mechanical neck pain, who were randomly divided into an upper thoracic manipulation group and a cervical stability training group. Upper thoracic manipulation after cervical stability training was conducted for the upper thoracic manipulation group, and only stability training was conducted for the cervical stability training group. The intervention period was six weeks, and consisted of three sessions a week, each of which lasted for 30 minutes. For proprioception measurement, an electro-goniometer was used to measure reposition sense before and after the intervention. The visual analogue scale was used to assess pain. [Results] After the intervention, the error angle was significantly smaller in flexion and right left side-bending, and pain was significantly reduced in the upper thoracic manipulation group. According to the post intervention comparison of the two groups, there were significant differences in the proprioception and pain values. [Conclusion] Conducting both cervical stability training and upper thoracic manipulation for patients with chronic neck pain was more helpful for the improvement of proprioception and pain than cervical stability training alone.
Key words: Neck pain, Manipulation, Proprioception

(This article was submitted Sep. 1, 2014, and was accepted Oct. 24, 2014)

INTRODUCTION

Neck pain is a disease that most people experience at least once in their life time. Neck pain is the main cause of an increase in economic and social health costs. To treat neck pain, physical therapists often use therapeutic exercise, traction, joint mobilization, and manipulation[1, 2)].

In the case of the patients with chronic neck pain, because of overuse, repetitive trauma, serious trauma and muscle weakness, the range of elasticity of the non-contractile tissues becomes enlarged, and stablize the neutral position, and contractile tissues become weak. As a result, instability increases in the spinal segments, resulting in failure to maintain the neutral position. Joint instability is accompanied by loss of somatosensory system function. In addition, joint instability causes hyper-mobility of cervical segments, and restricts the movement of the thoracic segments, which ultimately leads to functional restriction[2)].

Manipulation and mobilization are clinically employed often to improve cervical instability and functional movement. Thoracic manipulation and joint mobilization help to increase the restricted mobility of the spinal segments, to improve cervical mobility and stability, and to recover functional movement and proprioception, and ultimately reducing pain and functional disorder[3, 4)].

In order to recover cervical proprioception in patients with chronic neck pain, a therapeutic approach is conducted to improve cervical instability, joint mobility, and neuromuscular control. Cranio-cervical flexor (CCF) training aims at recovery of control of the muscular system around the cervical spine and the recovery of cervical proprioception. For improvement in cervical joint mobility, manipulation and mobilization are performed[5)].

Previous studies have reported that direct cervical manipulation is a dangerous cervical treatment, because it can reduce the function of the spinal artery. For that reason, CCF training is widely employed to improve proprioception, pain and range of motion (ROM), and reduce the neck disability index (NDI) score of patients with neck pain[4, 6)].

Recently, indirect thoracic manipulation and mobilization have frequently been used to treat patients with neck pain, because it is safer than direct manipulation. Spinal manipulation elicits immediate effects on recovery of function, such as pain alleviation and ROM improvement, than conservative physical therapy. In addition, according to previous studies, manipulation is more effective at reducing pain than conservative muscle training[7)].

Nevertheless, there is still a lack of research evidence supporting the efficacy of manipulation. Therefore, the purpose of this study was to conduct cervical stability training

*Corresponding author. Byoungkwon Lee (E-mail: lbk6326@konyang.ac.kr)

(CST) and upper thoracic manipulation (UTM) for patients with chronic neck pain and investigate the changes in cervical proprioception and pain.

SUBJECTS AND METHODS

The subjects were 30 subjects with chronic mechanical neck pain who agreed to participate in this study. The inclusion criteria were: unilateral or bilateral pain in the posterior neck or shoulder region, and pain in the cervical region when moving or palpating the cervical region, which had lasted for more than 12 weeks, and was rated higher than four on a visual analogue scale (VAS). The exclusion criteria were: a diagnosis of cervical radiculopathy, previous experience of spinal manipulation, a history of fracture or dislocation of the cervical or thoracic spine, a history of surgical operation on the cervical or thoracic spine, hypertension, heart disease, or pregnancy.

The research protocol was approved by the Research Ethics Committee for Human Research of Konyang University, Korea.

UTM comprised 2 methods. Method 1: Upper thoracic lift manipulation. The subjects were asked to lock their fingers together, put their hands on the back of the neck, and sit in a chair without a back support. Then, a rolled towel was placed over the target spinal segment. A therapist stood behind the subject, and leant forward toward the rolled towel, or the target spinal segment. The therapist held the forearm of the subject, and flexed the subject's neck and upper thoracic completely up to the spinal segment, creating a force against the rolled towel using the subject's forearm, and held the subject's elbow in a horizontal adduction motion while lifting the subject toward the therapist in the posterior-anterior direction; and then applied thrust manipulation to the subject along with horizontal adduction and expiration[4].

Method 2: Thoracic manipulation in the supine position. The therapist stood next to the subject. And placed a hand on the subject's transverse process on the inferior segment of the target spinal segment. The subject puts his/her arms on the chest or locked their fingers at the back of the head and neck. The therapist held the subject's arms to keep the subject close, then put the manipulation hand on the target spinal segment and used the supporting hand to fix the subject's elbows with the therapist's forearm. After performing flexion up to the subject's target segment, the therapist applied thrust manipulation in the anterior-to-posterior direction while the subject inhaled and exhaled. The target segments were T1 to T4[4].

CTS consisted of static stability training for re-education and dynamic stability training for muscle endurance and power[8]. The static stability training used a pressure biofeedback unit (PBU), and it was based on CCF training for activating the deep muscles such as the longus colli and longus capitis. In dynamic stability training, the subjects maintained cervical flexion, and active assistive and active methods were conducted. After they had maintained cervical stability, the subjects performed dynamic training through extremity movement. The subjects were asked to pay attention to the cervical stability during training[9].

To measure the cervical proprioception of the patients

Table 1. Comparison of proprioception and pain within groups and between groups (N=30)

		Manipulation group (n=15)	Control group (n=15)
Flexion (angle)	Pre	6.07 (2.02)	5.67 (2.06)
	Post	2.47 (1.55)$^{\dagger **}$	4.27 (1.44)$^{\dagger,\ddagger **}$
Extension	Pre	4.87 (1.81)	4.87 (2.48)
	Post	3.27 (0.96)$^{\dagger **}$	3.53 (1.81)$^{\dagger **}$
Rt sidebend	Pre	6.20 (1.79)	6.73 (2.55)
	Post	1.87 (1.30)$^{\dagger **}$	5.00 (2.14)$^{\dagger,\ddagger **}$
Lt sidebend	Pre	6.60 (1.55)	6.53 (1.89)
	Post	1.00 (1.20)$^{\dagger **}$	4.67 (1.88)$^{\dagger,\ddagger **}$
VAS	Pre	7.13 (0.83)	6.93 (1.44)
	Post	1.93 (0.70)$^{\dagger **}$	3.40 (0.74)$^{\dagger,\ddagger **}$

Values are expressed as mean (SD)
*$p<0.05$, **$p<0.01$, †Within group comparison, ‡Between group comparison

with chronic neck pain, the cervical reposition test was conducted using an electro-goniometer (Mobee, Bitburg, 2013, Germany). The study subjects were asked to sit in an upright position comfortably in a chair. The target position was randomly chosen from among 30%, 60%, and 90% of the maximal ROM. The subjects kept the target position for 3 seconds, repeated it 5 times[10]. For measurement, the reposition test was conducted at the set angle 3 times. The rest time between measurements was 15 seconds. Measurement directions were set to flexion, extension, right and left side-bending. The subjects were asked to sit upright and wear black sunglasses to inhibit their vision, and to move actively toward the target position in a random order. The difference between the target angle and the actual angle was used in the analysis[11]. All subjects were asked to mark on a VAS scale ranging from 0 to 10 for the subjective assessment of pain. VAS is a simple way for the subjects to express their level of pain and has high reproducibility. It is also an evaluation method with high validity (r=0.77) and reliability (r=0.99)[12] (Table 1).

For data analysis, SPSS version 18.0 (SPSS, Inc., Chicago, USA) was used. Frequency analysis and descriptive statistics were employed to compare the general characteristics of the subjects. The independent t-test was conducted to compare the thoracic manipulation group and the CST group. The paired t-test was performed to compare the pre- and post intervention results of the UTM and the CST. The level of statistical significance was chosen as 0.05.

RESULTS

There were 8 male and 7 female in the manipulation group, and 7 male and 8 female in the control group. The mean age of the subjects was 30.80 years in the manipulation group and 28.07 years in the control group. The average weight, height and BMI were 63.23 kg, 164.87 cm and 23.20 kg/m^2, respectively in the manipulation group, and 62.89 kg, 168.13 cm and 21.93 kg/m^2, respectively in the control group. The UTM showed significantly smaller repositioning error in flexion and right and left side-bending and greater reduction in pain than the CST group (p<0.01). Both the UTM and CST groups showed significant differences in proprioception and pain after the intervention (p<0.01).

DISCUSSION

In this study, CST was conducted for the patients with chronic neck pain, followed by UTM for six weeks. After that, the changes in proprioception and pain were analyzed. After the interventions, the UTM group showed significant reductions in error angles which were less than those in the CST group, and the pain level of the UTM group was also significantly reduced.

Proprioception receptors, such as mechanoreceptors and free nerve endings, are found in the skin, facial, muscles, tendons, joint capsules, and ligaments. When active or passive movement occurs, receptors transmit the movement information to the central nervous system (CNS)[13]. High velocity low amplitude manipulation stimulates mechanoreceptors located in the muscles, ligaments, and joint capsules improving their responses in transmitting to the CNS; thus, helping the recovery of proprioception. It is known that manipulation mechanically stimulates joint capsules and thus leading to increased mobility of the spinal segments and increases ROM, which lessens the fear of movement by smoothly transmitting movement information to the CNS, thereby reducing pain[1, 14].

According to many previous studies, the combined approach of a therapeutic exercise program and manipulation is more effective at recovering the proprioception of patients with neck pain and their functions through pain reduction than any other kind of intervention[15].

Cassidy et al.[16] independently conducted both manipulation and joint mobilization for patients with mechanical neck pain, and reported the two groups showed significant improvements in pain and ROM after the interventions.

Joint mobilization conducted for the patients with chronic RA helped to increase their pain threshold[17]. Another hypothesis regarding pain reduction after manipulation is that beta-endorphins are expressed and that this alleviates pain[18]. According to Vernon et al.[19], after manipulation, beta-endorphins increased for five minutes, but 15 minutes later, their level had returned to its original state. According to the results of the present study, proprioception and pain were significantly reduced after UTM, a result that is consistent with the empirical evidence of previous studies.

Another proposal is that spine manipulation activates type I (static movement) and type II (dynamic movement) mechanoreceptors, which are distributed in passive and active structures, sending signals through the CNS to the periaqueductal grey area, the pain control system around the cerebral aqueduct of mid-brain, which increases the pain threshold to control pain[20].

The results of this study show that the thoracic manipulation group displayed more significant differences in pain reduction than the cervical stability group, and that CST also improved proprioception and pain. According to the study of Panjabi[21], cervical stability is maintained by the stability passive and active tissues and the capability of neuromuscular control. The purpose of the passive system is to use the elasticity of passive tissues including ligaments, joint capsules, and tendons to stabilize the neutral position. The purpose of the active system is to use the force generated by active tissues like muscles to maintain the neutral position. In addition, the neuromuscular control system controls and amplitude of the overall range and mobility. The CST result was consistent with the theory that training improves the stability the neutral position and its maintenance through the activation of the active tissues of muscles.

Despite these results, this study had several limitations. For example, the number of study subjects small, and there was no long-term intervention of manipulation or CST. Therefore, we consider that it will be necessary to increase the number of study subjects and lengthen the intervention period to prove the effects of manipulation. In the present study, the repositioning test was conducted to measure the propriocetive deficit. However, this is an indirect method, not a direct one, of measuring proprioception. For that reason, it is impossible to generalize the results. Therefore, we think that a more objective tool and measurement method will be needed to investigate proprioception.

In summary, the UTM group showed significant improvements in cervical proprioception, and significant reduction in pain, which were larger than those of the CST group. The findings of this study indicate that combine stability training and thoracic manipulation for patients with neck pain improves proprioception and reduces pain level.

REFERENCES

1) Cleland JA, Childs JD, McRae M, et al.: Immediate effects of thoracic manipulation in patients with neck pain: a randomized clinical trial. Man Ther, 2005, 10: 127–135. [Medline] [CrossRef]
2) Cross KM, Kuenze C, Grindstaff TL, et al.: Thoracic spine thrust manipulation improves pain, range of motion, and self-reported function in patients with mechanical neck pain: a systematic review. J Orthop Sports Phys Ther, 2011, 41: 633–642. [Medline] [CrossRef]
3) Cleland JA, Childs JD, Fritz JM, et al.: Development of a clinical prediction rule for guiding treatment of a subgroup of patients with neck pain: use of thoracic spine manipulation, exercise, and patient education. Phys Ther, 2007, 87: 9–23. [Medline] [CrossRef]
4) Olson KA: Manual Physical Therapy of the Spine. Elsevier Health Sciences, 2008.
5) Chiu TT, Law EY, Chiu TH: Performance of the craniocervical flexion test in subjects with and without chronic neck pain. J Orthop Sports Phys Ther, 2005, 35: 567–571. [Medline] [CrossRef]
6) Suvarnnato T, Puntumetakul R, Kaber D, et al.: The effects of thoracic manipulation versus mobilization for chronic neck pain: a randomized controlled trial pilot study. J Phys Ther Sci, 2013, 25: 865–871. [Medline] [CrossRef]
7) Ferreira LA, Santos LC, Pereira WM, et al.: Analysis of thoracic spine thrust manipulation for reducing neck pain. J Phys Ther Sci, 2013, 25: 325–329. [CrossRef]
8) Zachazewski JE, Quillen WS, Magee DJ: Pathology and Intervention in Musculoskeletal Rehabilitation. Elsevier Health Sciences, 2008.
9) Falla DL, Jull GA, Hodges PW: Patients with neck pain demonstrate reduced electromyographic activity of the deep cervical flexor muscles during performance of the craniocervical flexion test. Spine, 2004, 29: 2108–2114. [Medline] [CrossRef]
10) Newcomer K, Laskowski ER, Yu B, et al.: The effects of a lumbar support on repositioning error in subjects with low back pain. Arch Phys Med Rehabil, 2001, 82: 906–910. [Medline] [CrossRef]
11) Armstrong BS, McNair PJ, Williams M: Head and neck position sense in whiplash patients and healthy individuals and the effect of the craniocervical flexion action. Clin Biomech (Bristol, Avon), 2005, 20: 675–684. [Medline] [CrossRef]
12) Wilkie D, Lovejoy N, Dodd M, et al.: Cancer pain intensity measurement:

concurrent validity of three tools—finger dynamometer, pain intensity number scale, visual analogue scale. Hosp J, 1990, 6: 1–13. [Medline] [CrossRef]

13) Groen GJ, Baljet B, Drukker J: Nerves and nerve plexuses of the human vertebral column. Am J Anat, 1990, 188: 282–296. [Medline] [CrossRef]
14) Paris SV: Spinal manipulative therapy. Clin Orthop Relat Res, 1983, (179): 55–61. [Medline]
15) Ko T, Jeong U, Lee K: Effects of the inclusion thoracic mobilization into cranio-cervical flexor exercise in patients with chronic neck pain. J Phys Ther Sci, 2010, 22: 87–91. [CrossRef]
16) Cassidy JD, Lopes AA, Yong-Hing K: The immediate effect of manipulation versus mobilization on pain and range of motion in the cervical spine: a randomized controlled trial. J Manipulative Physiol Ther, 1992, 15: 570–575. [Medline]
17) Dhondt W, Willaeys T, Verbruggen LA, et al.: Pain threshold in patients with rheumatoid arthritis and effect of manual oscillations. Scand J Rheumatol, 1999, 28: 88–93. [Medline] [CrossRef]
18) Vicenzino B, Gutschlag F, Collins D, et al.: An investigation of the effects of spinal manual therapy on forequarter pressure and thermal pain thresholds and sympathetic nervous system activity in asymptomatic subjects: a preliminary report. Moving in on Pain Conference, 1995: 185–193.
19) Vernon HT, Dhami MS, Howley TP, et al.: Spinal manipulation and beta-endorphin: a controlled study of the effect of a spinal manipulation on plasma beta-endorphin levels in normal males. J Manipulative Physiol Ther, 1986, 9: 115–123. [Medline]
20) Cannon JT, Prieto GJ, Lee A, et al.: Evidence for opioid and non-opioid forms of stimulation-produced analgesia in the rat. Brain Res, 1982, 243: 315–321. [Medline] [CrossRef]
21) Panjabi MM: The stabilizing system of the spine. Part I. Function, dysfunction, adaptation, and enhancement. J Spinal Disord, 1992, 5: 383–389, discussion 397. [Medline] [CrossRef]