

Immediate and short-term effects of thoracic manipulation with neck muscles stretching compared with neck muscles stretching on alteration of pain and range of motion in mechanical neck pain

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ABSTRACT

Background: Mechanical neck pain is generally found among manual workers. Manual therapy is one of treatment for patients with neck pain. Alternatively, thoracic spine thrust manipulation may efficiently treat mechanical neck pain. Therefore, treatment using biomechanical connection between cervical and thoracic spine can increase joint mobility for improvement of neck disorders.

Objectives: To investigate the immediate effects of post-test (48-72 hours and short-term 2 weeks follow up) of thoracic manipulation in combination with stretching exercise on mechanical neck pain, pressure pain threshold, Neck Disability Index (NDI), forward head posture, and cervical range of motion.

Materials and methods: Forty patients with neck pain were recruited in the study. Participants were divided into four groups: (1) thoracic manipulation; (2) thoracic manipulation with stretching exercise; (3) stretching exercise; and (4) control.

Results: There was a statistically significant difference between outcomes of the groups. Thoracic manipulation with stretching exercise group had better results than that of manipulation, stretching group, and control group on visual analog pain scale. Statistically significant difference was found when its effect was to the stretching and control group on NDI and pressure pain threshold. Thoracic manipulation with stretching exercise group had a statistically significant difference when compared to stretching, control group on forward head posture, and cervical range of motion in extension direction.

Conclusion: Thoracic manipulation may be an alternative treatment in mechanical neck pain in producing more benefits when is used in combination with stretching exercise to decrease neck pain, increase cervical range of motion, and tends to neutralize head posture decreasing neck disability.

Introduction

Neck pain is prevalent in thirteen percent of the population at any given time, and is experienced by fifty percent of the population over their lifetimes.¹ Mechanical

neck pain is generally found among the general and workforce population. Risk factors for this disorder include poor posture and occupational activities.

Manual therapy like cervical manipulation and exercise is an alternative therapy for neck pain.² The advantages of cervical spine manipulation must be weighed against the risks, such as cervical spine fracture.³ Treatments that incorporate an understanding of the biomechanical connection between the cervical and thoracic spine can improve joint mobility, which alleviates pain and improves range of motion in patients with neck disorders.⁴ For this reason, it has

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been recommended that the incorporation of thoracic spine manipulation interventions may reduce inherent risks associated with manual therapy directed at the cervical spine while producing the same effects.⁵

Neck pain prevalence in the general population has been reported to be twenty-three percent in women and fifteen percent in men.⁶ A study on both thrust and non-thrust manipulation treatment directed at the cervical spine shows pain reduction, an improvement of cervical range of motion, and function in patients with neck pain.⁷ When procedures are compared, the study has reported similar clinical outcomes.⁸ However, cervical manipulation directed at the cervical spine must be reconsidered since it has potential disadvantage including vertebrobasilar artery injury.⁹ Because of the kinematic link between the cervical and thoracic spine, improvement of thoracic spine may alleviate neck pain and improve joint mobility of the cervical spine.⁴ Measurement of forward head posture by three-point markers and a comprehensive test with subjective and objectives has not been established from thoracic manipulation in neck pain. Therefore, thoracic manipulation may be an efficient method for treatment of mechanical neck pain.

The objectives of this study were to investigate the immediate and short-term (2 weeks) effects of thoracic manipulation, thoracic manipulation in combination with stretching exercise, and stretching exercise alone on mechanical neck pain, pressure pain threshold, Neck Disability Index (NDI), forward head posture, and cervical range of motion. This study has been approved by the ethical committee (69/2557), Burapha University, Thailand.

Materials and methods

Forty participants (9 males, 31 females) with mechanical neck pain, with an average age of 21 years old, were enrolled in this study.

Inclusion criteria were patients who were included in the study had mechanical neck pain for more than three months and limited range of motion of neck in all directions, the sixth or seventh thoracic spine hypomobility, and forward head posture. The participants were assessed for thoracic vertebral mobility and neck posture, confirmed by two five-year experienced orthopedic physical therapists. This study was conducted at the Faculty of Allied Health Sciences, Burapha University.

Exclusion Criteria were patients with cervical or thoracic spine subluxation or instability by assessment of passive physiological intervertebral movement and passive accessory intervertebral movement, central or peripheral nervous system involvement, signs consistent with nerve root compression and a diagnosis of cervical spinal stenosis, history of a whiplash injury within six weeks, osteoporosis, bone tuberculosis, tumors, fibromyalgia, spinal malignancy, and having cervicothoracic surgery or serious accidents within the previous four weeks and having received cervical or thoracic spine manipulation within the previous two weeks.

Participants were divided into four groups by simple randomization and received research protocols, ethics and

consent information:

- 1. Thoracic Manipulation Group.** Participants were asked to assume the prone position with their hands beside the trunk. Thoracic manipulation was then performed on the seventh thoracic spine by a single manipulation (central posteroanterior direction). If the cavitation (popping sound) was not produced during the first thoracic manipulation, participant would rest for one minute, after which there was second attempt at manipulation. Thoracic manipulation attempts were limited to two times.¹⁰
- 2. Thoracic Manipulation with Stretching Exercise Group.** A combination of thoracic manipulation (same procedure as thoracic manipulation group) along with stretching exercise for neck (suboccipital muscles, neck extensor muscles, and scalene muscle), and shoulder (upper trapezius muscle, pectoralis muscle) were performed. Stretching procedure was an active stretching exercise performed by patients on both sides, for 20-30 seconds per set, with five sets, was performed two times daily during a two-week home program in the morning and the evening, for about 10-15 minutes per session. Stretching exercise was provided and assessed by the same physical therapist that performed the thoracic manipulation.
- 3. Stretching Exercise Group.** Participants received only neck and shoulder stretching exercise, and performed active stretching exercise for two-week home program as applied in group 2.
- 4. Control Group.** Participants received 15 minutes of health education about correct neck and trunk posture, ergonomics, and lifting by the second physical therapist who has more than five years of orthopedic clinical experience.

Outcome Measurements

Primary and secondary outcome parameters were measured four times by the third physical therapist. The measurements occurred before, immediately, post-test (48-72 hours), and short-term after treatment.

Primary Outcome Measurements

Visual Analog Scale for Pain (VAS-P 100 mm): Participants were asked to use a pencil marked in a 100 mm straight line. The therapist evaluated the distance from zero point. A higher score signifies more pain. Pain scales were evaluated on time periods.

Secondary Outcome Measurements

1. Neck Disability Index: (NDI)¹¹ was evaluated using questionnaires.
2. Pressure Pain Threshold (PPT) using a PPT Device; Algometer (The Commander Algometer; JTECH MEDICAL INDUSTRIES, INC., USA) was evaluated using a perpendicular press on the suboccipital muscle.
3. Forward Head Angle, using a three-point marker software, with high reliability (ICC=0.99)¹² was evaluated using a real time image of the lateral view, reporting the angle degree using a marker that was placed on the mastoid bone, the spinous process of

the seventh cervical spine, and the acromion process.

4. The study incorporated the Cervical Range of Motion (neck extension ROM), using a double inclinometer (Baseline Bubble Inclinometer, Baseline® measurement instrument, USA) by placing the first one on the top of head and the second one on the spinous process of the seventh cervical spine. Then, extension occurred until the second one's score moved. Finally, the score for the first one on the top of the head was read. Average score from repeating this process three times were determined.

Sample Size Determination

Simple randomizing by random lots was applied. It was a single blind randomized control trial. Sample size determinations, (the accuracy for this study is considered to be eighty percent) were conducted in reference to Cleland et al¹⁴ by means of thrust and non-thrust logic plus a 20 percent drop out. There were ten persons per group and this study compared four different treatment groups. Therefore, the four groups consisted of forty persons. Calculation was derived from the primary outcome measurements by mean different of visual Analog Scale for Pain.

Data Analysis

Parametric data mean±SD (VAS-P, PPT, forward head angle, neck extension ROM) and non-parametric data of NDI were compared between groups in the following time periods: pretests followed by immediate tests; pretests followed by post-tests within 48-72 hours; and pretests followed by post-tests performed two weeks later (such as comparing group 1 and group 2 in immediate post-tests), not calculated within group on time periods. Independent paired t-Test (ratio scale with Parametric data; NDI used non-parametric test) was used by matching comparisons between time periods between groups at statistical significance of $p < 0.05$.

Results

Forty participants (9 males and 31 females) with an average age of 21 years old enrolled in this study. The average body mass index was within normal range. All participants were right-handed. Details of age, gender, weight, height, and body mass index are shown in Table 1. Study parameters making comparisons between groups and time periods are shown in Table 2.

Table 1 Baseline characteristic of participants.

Group	Manipulation	Stretching	Manipulation and stretching	Control
Age mean±SD	21.3±0.8	21±0.7	21.6±2	21
Gender	Male 2 Female 8	Female 10	Male 3 Female 7	Male 4 Female 6
Weight (Kg.) mean±SD	59.5±5.4	58.9±9.1	54.8±14.1	63.7±12
Height (Cm.) mean±SD	165.6±7.2	161.2±3.7	161.6±6.1	163.5±5.4
Body Mass Index (Kg./m ²) mean±SD	21.8±3.8	22.6±5.1	20.6±4	24.7±5.2
Handed	All right handed	All right handed	All right handed	All right handed

Table 2 Study parameters compared between groups and time periods.

Group	Compared with	Time periods	Pain	NDI	PPT	FHP	Neck extension ROM
Manipulation with stretching group	Manipulation group	Post test immediately	0.606	0.054	0.635	0.118	0.002*
		Post test 48-72 Hour	0.012*	0.701	0.029*	0.634	0.137
		Post test 2 weeks	0.002*	0.219	0.373	0.981	0.001*
	Stretching group	Post test immediately	0.011*	0.003*	0.436	0.475	0.002*
		Post test 48-72 Hour	0.047*	0.489	0.342	0.195	0.137
		Post test 2 weeks	0.029*	0.21	0.034*	0.001*	0.001*
	Control group	Post test immediately	0.001*	0.001*	0.034*	0.004*	0.002*
		Post test 48-72 Hour	0.027*	0.014*	0.002*	0.129	0.137
		Post test 2 weeks	0.008*	0.001*	0.02*	0.103	0.001*

Table 2 Study parameters compared between groups and time periods. (continues)

Group	Compared with	Time periods	Pain	NDI	PPT	FHP	Neck extension ROM
Manipulation group	Stretching group	Post test immediately	0.21	0.309	0.211	0.041*	0.002*
		Post test 48-72 Hour	0.467	0.423	0.007*	0.093	0.137
		Post test 2 weeks	0.239	0.879	0.376	0.001*	0.001*
	Control group	Post test immediately	0.015*	0.002*	0.004*	0.004*	0.002*
		Post test 48-72 Hour	0.63	0.013*	0.001*	0.059	0.137
		Post test 2 weeks	0.404	0.018*	0.003*	0.123	0.001*
Stretching group	Control group	Post test immediately	0.001*	0.002*	0.015*	0.001*	0.002*
		Post test 48-72 Hour	0.783	0.089	0.007*	0.687	0.137
		Post test 2 weeks	0.622	0.07	0.001*	0.001*	0.001*

NDI: neck disability index, PPT: pressure pain threshold, FHP: forward head posture, ROM: range of motion; * $p < 0.05$

Visual Analog Scale for Pain

Manipulation with the stretching group had decreased pain statistically significant when compared with the manipulation group in the 48-72 hour post-test ($p=0.012$) and the two-week post-test ($p=0.002$). There were statistical differences compared with stretching group in the immediate post-test ($p=0.011$), 48-72 hour post-test ($p=0.047$) and the two-week post-test ($p=0.029$) as well as statistical differences compared with the control group in the immediate post-test ($p=0.001$), the 48-72 hour post-test ($p=0.027$) and the two-week post-test ($p=0.008$).

Manipulation group had no statistical difference in pain from stretching group on three time post-tests. However, there was a statistical difference in pain compared with control group in the immediate post-test ($p=0.015$). There was also statistical difference between stretching group and control group in the immediate post-test ($p=0.001$).

Neck Disability Index (NDI)

Manipulation with stretching group had no statistical difference compared with manipulation group in all post-test time periods. Statistical differences was found when compared with stretching group in the immediate post-test ($p=0.003$) (a high score signifies high disability). There was also found the statistical differences when compared to control group in all three post-test time periods.

There was no statistical difference between the manipulation group and the stretching group in all post-test time periods. There was a statistical difference between stretching group and control group in immediate post-test ($p=0.002$).

For NDI parameter, a high score signifies high disability. Manipulation with stretching group had no statistical difference in NDI scores compared with the manipulation group in all post-test time periods. On the other hand, NDI scores were statistical different when compared with the stretching group, in the immediate post-test ($p=0.003$). There was also found the statistical differences when compared to the control group in all three post-test time

periods.

The manipulation group showed no statistical difference in NDI scores compared to the stretching group, in all post-test time periods. There was a statistical difference between stretching group and control group in immediate post-test ($p=0.002$).

Pressure Pain Threshold

Manipulation with stretching group had statistical differences when compared to manipulation group in the 48-72 hour post-test ($p=0.029$) (increased pain threshold), the stretching group in the two-week post-test ($p=0.034$), the control group in the immediate post-test ($p=0.034$), the 48-72 hour post-test ($p=0.002$), and the two-week post-test ($p=0.02$).

Manipulation group had statistical differences compared to stretching group and control group in the 48-72 hour post-test ($p=0.007$). There were also statistical differences between the stretching group and the control group in the immediate post-test ($p=0.015$), the 48-72 hour post-test ($p=0.007$) and the two-week post-test ($p=0.001$).

Forward Head Posture¹²

Manipulation with stretching group had no statistical difference compared with manipulation group in all post-test time periods. Statistical difference was found when compared to stretching group in the two-week post-test was ($p=0.001$, and control group in the immediate post-test was ($p=0.004$). A decreased forward head posture angle signified good posture.

Manipulation group had statistical difference compared to stretching group in immediate post-test ($p=0.041$) and two weeks post-test ($p=0.001$). Statistical difference was also found when compared to control group in the immediate post-test ($p=0.004$).

Stretching group had statistical difference compared with control group in the two-week post-test ($p=0.001$).

Neck Extension Range of Motion

Manipulation with stretching group had statistical differences compared to manipulation group in the immediate post-test ($p=0.002$) and the two-week post-test ($p=0.001$). Statistical differences were found when compared to stretching group in the immediate post-test ($p=0.002$), and in the two-week post-test ($p=0.001$); control group in the immediate post-test ($p=0.002$), and in the two-week post-test ($p=0.001$).

Manipulation group had statistical differences compared to stretching group in the immediate post-test ($p=0.002$) and in the two-week post-test ($p=0.001$). Statistical differences were found when compared with the control group in the immediate post-test ($p=0.002$), and in the two-week post-test ($p=0.001$).

There was statistical difference between stretching group and control group in immediate posttest ($p=0.002$) and the two-week post-test ($p=0.001$).

Discussion

Manual therapy can improve all parameters but different in specific mechanisms by applying mechanical stress to different structures, such as thoracic manipulation, specifically thoracic zygapophyseal joint and stretching specifically to the neck muscles.² Manipulation with stretching group had statistically significant improved in the visual analog scale for pain between groups compared to manipulation, stretching, and control group in all time periods. The exception was found in manipulation group in immediate effect. It meant that manipulation has the same benefit in decreasing pain by increasing pain threshold in suboccipital muscle. Since it was found that improvement of thoracic spine mobility by manipulation also increases cervical spine mobility when compared to control group in all post-test time periods. Therefore, decreasing forward head posture will decrease load on suboccipital muscles in holding head all the time in order to correct head posture and leads to neck pain. New advantage of this study was real time forward head posture by three-point marker.¹² The results suggest that thoracic spine manipulation has immediate analgesic effects in patients with mechanical neck pain through use alone¹¹ and pain decreases after thoracic manipulation in mechanical neck pain, as measured by the numeric pain rating scale.¹³

The pressure pain threshold improved in all but not control group. More benefits were found in stretching group. The reasons may arise from the direct manual stretch and measurement at the neck muscle. Interestingly, thoracic manipulation group has benefited from decreased neck muscle pain.

NDI had a statistically significant improved in immediate effects when compared to manipulation and stretching group. Moreover, stretching group has shown a statistically significant improvement in all time periods when compared to control. Manipulation played a significant role in decreasing neck disability, according to Cleland *et al*¹⁴ contrary to Cleland *et al*¹¹ according to which neck disability has no statistically significant improvement after

thoracic manipulation. Conversely, Lau *et al*¹³ reported that thoracic manipulation improves neck disability using the Northwick Park Neck Disability Questionnaire.¹³ Interestingly, stretching group has benefited in the 48-72 post-test and the two-week post-test to decrease neck disability. However, there was no statistical significance when compared to manipulation and stretching group. When compared to previous studies, this study had the advantage of using participants who, on average, were younger and had less pain and lower neck disability scores. NDI parameters was improved after manipulation with stretching or manipulation. This result may closely correlate to neck function and thoracic mobility.¹⁵ Improvements on the thoracic spine increase flexibility of neck muscles.

There was improvement on forward head posture after thoracic manipulation and stretching as found in manipulation with stretching group treatment. Participants could erect the neck to a neutral position better than manipulation group. The result was according to Lau *et al*¹³ that reported thoracic manipulation increased the craniocervical angle (CV angle).^{13,16} The authors suggested that there are close and link chain of thoracic spine and cervical spine. Increasing the mobility of the thoracic spine, as when the spine returns to the neutral position, results in improved cervical spine mobility. An increase in thoracic spine mobility causes increased vertebral spine mobility in case of thoracic spine decreases movement or stiffness. The effect is to decrease the curve of thoracic area which tends to increase activity and load on the neck and occipital muscle. Forward head posture leads to a slouch posture and causes head to point down. This effects suboccipital muscles to increase the load by pulling the head to the correct position. These mechanisms lead to neck pain and explain how thoracic manipulation can treat neck pain. Suboccipital muscle is an important part of neck extensor, which responsible for high load and continuous contraction. Alterations of neck extensor muscle action in neck pain study has reported that superficial cervical extensors regularly present increased activation in patients with neck pain¹⁷ and delayed offset (relaxation).

An increased in neck extension range of motion leads to improvement of forward head posture. Stiffness of thoracic spine also affects the cervical spine. Therefore, thoracic manipulation promotes cervical movement. Moreover, neck muscle stretching showed more advantage by maintaining better neck movement in the two-week post-test. Quality of life may increase. However, it was not measured in this study. It is likely to be measurable using a health-related quality of life status questionnaire (SF36 Questionnaire) which has found benefits of thoracic manipulation with patients who have chronic neck pain.¹⁴

The theory that biomechanical link between thoracic spine and cervical spine may lead to abnormal connection and distribution of forces and mobility in the cervical spine has lately been investigated.^{19,20} Thoracic spine manipulation may cause a restoration of more normal spine biomechanics. This may decrease mechanical stress and increase the distribution of joint forces from thoracic to cervical spine. Limitations are short-term follow-up and

a confounding factor needed to be controlled for in this study was the relative youth of the participants. Future research in this area should be focused in the long-term effects of thoracic spine manipulation in patients with mechanical neck pain on patient satisfaction and costs. Questionnaires might also be used.

Conclusion

Thoracic manipulation may be combined with standard physical therapy treatment in mechanical neck pain, and may provide more benefit when used in combination with stretching exercise to decrease neck pain, increase cervical range of motion, and improve head posture, leading to decreased neck disability.

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