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Original Article

# The effect of massage technique plus thoracic manipulation *versus* thoracic manipulation on pain and neural tension in mechanical neck pain: a randomized controlled trial

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**Abstract.** [Purpose] To determine the short-term effects of thoracic manipulation, used alone or in conjunction with the Rungthip massage technique, on pain and neural extensibility in patients with chronic mechanical neck pain. [Participants and Methods] Thirty participants were randomly allocated to the aforementioned two groups. Outcome measures were neck pain at rest assessed using the Visual Analog Scale, and elbow extension range of motion evaluated using Upper Limb Neurodynamic Test 1 prior to treatment and three weeks after it. [Results] A statistically significant reduction in resting neck pain, and an improvement in elbow extension range of motion was reported by both groups shortly after the moment when the pain was first felt (threshold level). However, an improvement in elbow extension range of motion was not observed in either group at the maximum level of pain (tolerance level). A significant reduction in resting neck pain was seen in the thoracic manipulation plus Rungthip massage group, compared to that achieved using thoracic manipulation alone. [Conclusion] The use of thoracic manipulation and Rungthip massage is recommended to reduce resting neck pain and increase pain-free neural tissue extensibility.

**Key words:** Mechanical neck pain, Thoracic manipulation, Rungthip massage technique

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## INTRODUCTION

Neck pain is a common musculoskeletal complaint in general and working-age populations[1)], with two-thirds of all people experiencing it at some point in their lives[2)]. The global prevalence of neck pain is estimated to be 30–50%[3, 4)]. Mechanical neck pain is the most common type that is experienced by the general population[5)].

The exact pathology of mechanical neck pain has not yet been fully elucidated but it has been suggested that it relates to various pain-sensitive structures, including the muscles, ligaments, zygapophyseal joints, uncovertebral joints, intervertebral discs, and neural tissue[6)].

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Neural tissue sensitivity has been cited as a possible cause of neck pain-related signs and symptoms, including pain and hypoalgesia of the muscles and joints in patients with neck pain[7, 8]. The characteristics of neck pain causes such as repetitive movements, an awkward posture, localized pressure, the excessive use of force, and sitting while working for ≥95% of the working day[2, 9, 10] alter the mechanical and physiological mechanisms of the neural tissue, leading to an increase in neural tension[11, 12]. It is thought that the narrowest and roundest spinal canal is found in the T6 intervertebral disc. As such, it is most vulnerable to tension, especially when nervous system movement affects the structures around it[11, 13].

Cervical spine manipulation is commonly used to treat mechanical neck pain conditions[14–18]. Potential risks include risk of Vertebrobaslilar Insufficiency[19] and ensuing complications, including headache, stiffness, and neurological deficit[16, 20]. Manual therapy interventions involving the spine have been shown to reduce pain in regions distal from the treatment area[21–24]. It has been proposed that disturbances to joint mobility in the thoracic spine contribute to a reduction in cervical spine-related symptoms, suggestive of a relationship between the biomechanical, anatomical, and neural structures of the cervical and thoracic spine[25–27].

Similarly, it is thought that thoracic manipulation provides the stimulus required to activate descending pain inhibitory mechanisms, thus achieving a hypoalgesic response in the distal areas[21, 28, 29]. It has also been suggested that performing thoracic manipulation at T6 level may enhance the mobility of the cervical spine, thereby leading to a reduction in dural ligament tension and neural tension[30, 31].

In recent years, several studies have investigated the impact of thoracic spine manipulation on mechanical neck pain[24, 32, 33]. However, only a few have evaluated the impact of thoracic manipulation of the zygapophyseal joints between the sixth and seventh vertebrae (T6–T7) on mechanical neck pain. A significant decrease in resting neck pain and an increase in cervical range of motion (ROM) was reported after thoracic manipulation at T6–T7 level[30, 31]. However, the effect of thoracic manipulation on the mechanosensitivity of the nervous system was not considered in these studies and it might have contributed to improved nerve mobility and tension.

Central postero-anterior mobilization techniques were performed in one study on the treatment lines beside the posterior vertebral line, from the level of the inferior angle of the scapula to the lowest rib. This gave rise to the development of the Rungthip massage technique, which has been shown to significantly reduce neck pain while at rest and increase the degree of cervical flexion and extension without any post-intervention adverse effects[34]. The founding principle of the Rungthip massage technique is identical to that of the mobilization technique. It has been demonstrated to reduce neural tension owing to improved mobility in the cervical and thoracic spine[16]. As well as being beneficial in a clinical setting, this technique can also be applied as an effective home remedy to treat neck pain with neural tissue-related problems because it is an easy procedure for the patient's relatives to follow, aided by therapist guidelines.

To date, there is no evidence to support the suggestion that thoracic manipulation, used in combination with the Rungthip massage technique, reduces neural tension during the recovery process of patients with chronic mechanical neck pain. Thus, the current study hypothesis was that a dual intervention (thoracic spinal manipulation applied to the zygapophyseal joints between the sixth and seventh vertebrae [T6–T7] in conjunction with the Rungthip massage technique) would achieve a reduction in resting neck pain and neural tension, and a related increase in elbow extension ROM, the latter of which would be measured by the Upper Limb Neurodynamic Test 1 (ULNT1), as described by Butler[13]. The study objective was to compare the short-term effectiveness of two alternative treatment approaches to chronic mechanical neck pain in patients, namely (i) spinal manipulation directed at the T6–T7 vertebral level in combination with the Rungthip massage technique and (ii) spinal manipulation directed at the T6–T7 vertebral level alone. The primary outcomes were neck pain while resting measured using Visual Analog Scale (VAS), and elbow extension ROM determined during the ULNT1.

## PARTICIPANTS AND METHODS

This study was an assessor-blinded, randomized clinical trial in which two groups were included; a treatment group who received thoracic manipulation in conjunction with the Rungthip massage technique, and a comparison group who received thoracic manipulation only. The study setting was the Department of Physical Therapy, Faculty of Associated Medical Sciences, Khon Kaen University, Thailand. The research protocol was approved by the Research Ethics Committee for Human Research of Khon Kaen University and registered under ClinicalTrials.gov Identifier: NCT03187808. The participants were asked to provide informed written consent prior to participation in the study.

Thirty participants with chronic mechanical neck pain (8 males and 22 females, aged 18–29 years (a mean of 23 ± 3.65 years) were recruited through advertising flyers that were posted within the local community area inviting participation in the research. For study purposes, mechanical neck pain was defined as pain in the posterior neck or shoulder with mechanical characteristics, accompanied by symptoms provoked by sustained neck posture, neck movement, or palpation of the cervical musculature[5]. The inclusion criteria were patients aged 18–59 years with chronic mechanical neck pain for ≥3 months, with a baseline VAS pain rating score of ≥3 prior to data collection. The participants were asked to complete a screening questionnaire to ensure that they met the inclusion criteria. Thereafter, they underwent a standard subjective and physical examination administered by an experienced physical therapist.

The exclusion criteria were: 1) a diagnosis of cervical radiculopathy or myelopathy; 2) a history of whiplash injury; 3) a history of cervical surgery and/or thoracic surgery; 4) a history of cervical and/or thoracic injuries (including fracture or dislocation); 5) a diagnosis of fibromyalgia syndrome; 6) previous spinal manipulation within two months of participation in the present study; 7) serious spinal pathology (including spinal osteoporosis, spinal tuberculosis, and tumors); and 8) hypertension, heart disease, and meningitis.

The sample size was calculated using the average level of neck pain (while resting) in the intervention and control groups, after conducting a preliminary procedure involving 10 participants per group. Average pain while at rest in the thoracic manipulation group and in the thoracic manipulation plus Rungthip massage technique group was 23.1 ± 10.99 mm and 9.8 ± 6.68 mm, respectively. The variance was calculated using the equation: $\sigma^2=(n_1-1)s_1^2 + (n_2-1)s_2^2/(n_1+n_2)-2$ and the result was used to determine the sample size. The latter was calculated using the following statistical formula: $n=2\sigma^2(Z_\alpha+ Z_\beta)^2 / (\mu_1-\mu_2)^2$. Statistical significance was set at $\alpha=0.05$ to establish the sample size and the power of the test was calculated to be 90%. The final number of included participants was 15 persons per group (i.e., a total of 30 participants).

After the baseline examination, each participant was randomly assigned either to receive thoracic manipulation, or thoracic manipulation followed by the application of the Rungthip massage technique. A stratified block randomized allocation was utilized (block sizes of 4, 6, and 8) by a researcher who was not involved in the evaluation nor treatment processes (Fig. 1). Concealed allocation was executed using a computer generated randomized table of numbers. Sequential numbered cards were placed in opaque sealed envelopes.

The VAS was used to record pain intensity in each individual while at rest as the primary outcome. The participants rated their average pain over the last 24 hours on a 100 mm horizontal line, with "0" representing no pain and "100" denoting the highest level of pain possible. The VAS is known to be a valid and reliable outcome measure (intraclass correlation coefficient of 0.97)[35–37]. The participants were asked to record their pain levels (using VAS) at baseline before commencing treatment and on completion of the intervention (i.e., the day after three weeks of treatment).

A digital goniometer was used to measure the secondary outcome was elbow extension ROM. It was calibrated to 0° against a universal goniometer for elbow extension ROM prior to commencement of the testing procedure. Prior to assessing ULNT1, the participants were informed about the test procedure and were asked to verbally communicate their responses and the location of symptoms during the test.

The threshold level (P1) was defined as the first moment when the symptoms (e.g. strain, tightness, tension, numbness, and pins and needles) were felt on the tested upper limb, while the tolerance level (P2) was defined as the most excessive strain or pain. The data were recorded when the participant pronounced the words "strain" and "stop," respectively. The ULNT1 protocol[13, 38] was performed on the dominant upper limb of each participant. The participants were tested while in the supine position on an examination bed without a pillow, with the cervical spine in a neutral position. The shoulder girdle was stabilized manually so that the upper arm was abducted to 110° by a secured stainless block that was designed to fix the range of shoulder abduction. The wrist and fingers were extended, the forearm was supinated, and the shoulder was laterally rotated to 90°, after which elbow extension was performed. The examiner ensured that the correct posture was being maintained before taking the subsequent measurement for each component of the test. Threshold (P1) and tolerance levels (P2) for elbow extension ROM was recorded using a digital goniometer administered by an assistant researcher. The axis of the digital goniometer was positioned at the medial epicondyle of each participant's humerus. The stationary arm of the goniometer was aligned with the midline of the humerus and the moveable arm was aligned to be parallel with the midline of the ulna[39]. The examiner performed two repetitions of the test measurement, with a two-minute break between repetitions.

Thoracic manipulation was performed directly on both sides of the T6–T7 zygapophyseal joints of the control group participants at each treatment session. The participants were asked to lie in the prone position on the examination table and instructed to inhale and exhale deeply. During exhalation, the therapist performed thoracic manipulation (screw thrust technique) at the T6–T7 zygapophyseal joints, as described by Maitland et al[6]. If a popping sound was not heard on the first attempt, the therapist repositioned the participant and performed a second manipulation. A maximum of two attempts was carried out within two minutes.

Thoracic manipulation was likewise performed at the same site in the intervention group participants, followed by a one-minute break, after which the Rungthip massage technique was administered. The latter was performed with the participants in the side-lying position, with 90 degrees of hip flexion and 90 degrees of knee flexion. The therapist gently pressed her thumb along the treatment lines from the level of the inferior angle of the scapula to the lowest rib. Three repetitions were performed along each treatment line (Fig. 2).

The treatment was conducted by the same therapist with training and experience in spinal manipulation. Both groups received six intervention sessions, comprising two treatment sessions per week delivered over three consecutive weeks. Neck care education, including advice on how to adopt a neutral sitting posture and safe lifting posture, was given to all the study subjects. The outcome measures were assessed at baseline and on the day after completion of the last treatment session.

Statistical analysis was performed using SPSS Statistics® version 17.0. Descriptive statistics were used to calculate and summarize the general characteristics of the participants, expressed as mean and standard deviation (SD). The Kolmogorov-Smirnov test was conducted to verify the normal distribution of the variables for both groups. The paired t-test was utilized to evaluate the difference in elbow extension ROM within the groups pre- and post the intervention. Analysis of covariance (ANCOVA), having adjusted the baseline values, was employed to calculate any differences between the groups regarding pain levels while at rest, as well as elbow extension ROM. A p-value of $\leq 0.05$ was considered to be statistically significant.

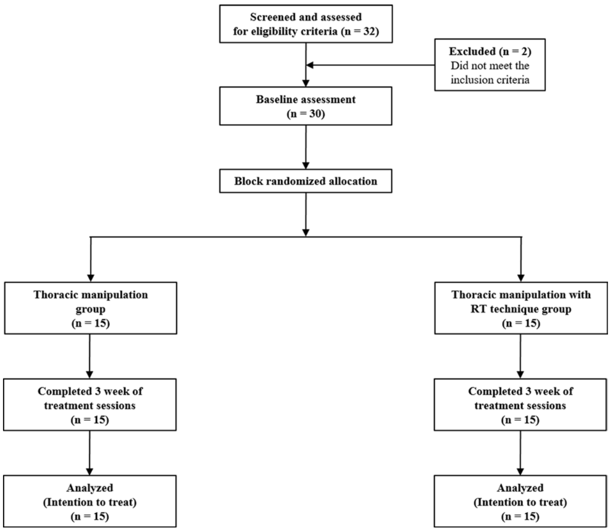


**Fig. 1.** Flowchart diagram of this study.

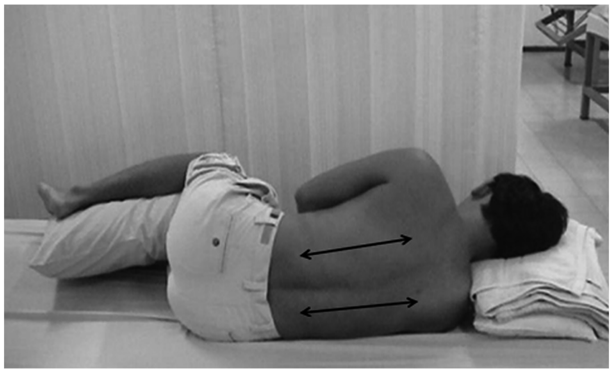

**Fig. 2.** Massage technique (RT technique).

## RESULTS

Thirty-two consecutively presenting participants were screened for eligibility over a six-month period (August 2016 to January 2017). Two of the patients (6.25%) did not meet the inclusion criteria for this study. The remaining 30 participants (23.17 ± 3.65 years [mean ± SD]; 73.33% of whom were female) satisfied the eligibility criteria, agreed to participate, and were randomly assigned to receive thoracic manipulation (n=15) or thoracic manipulation in combination with the Rungthip massage technique (n=15). There was no significant difference in the demographic data of the participants in either group when the baseline measurements were taken ($p \geq 0.05$) (Table 1).

A significant reduction in pain intensity and was observed in both groups using VAS post the intervention (Table 2). Slightly better pain intensity results, measured using VAS, were attributed to the thoracic manipulation in combination with the Rungthip massage technique group. A statistically significant difference in VAS scores was demonstrated in favor of the thoracic manipulation in combination with the Rungthip massage technique group using ANCOVA post the intervention during the intergroup comparison ($p \leq 0.05$) (Table 3).

## DISCUSSION

The current study objective was to evaluate and compare the impact of thoracic manipulation, and thoracic manipulation in combination with the Rungthip massage technique, on pain levels while at rest and on neural tissue extensibility after three weeks of treatment (six sessions of each intervention) in participants with chronic mechanical neck pain. A significant decrease in neck pain while at rest and a reduction in neural mechanosensitivity was achieved using both approaches following the measurement of neck pain using VAS, and elbow extension ROM using the ULNT1 test, in this randomized controlled trial.

However, the dual intervention was more effective in decreasing pain while at rest than thoracic manipulation alone. Elsewhere, it was demonstrated that thoracic manipulation and the Rungthip massage technique immediately decreased neck pain while at rest in patients with chronic mechanical neck pain[30, 31]. However, the limitation of these studies was that either thoracic manipulation or the Rungthip massage technique were evaluated in isolation (i.e., alone)[30, 31]. The effects of the combination of thoracic manipulation in conjunction with the Rungthip massage technique have not previously been evaluated against the results achieved using thoracic manipulation alone when treating chronic mechanical neck pain.

The reduction in pain at rest was probably due to neurophysiological mechanisms associated with both thoracic manipulation and the Rungthip massage technique. For example, the application of thrust joint manipulation to the thoracic spine (specifically to the T6/T7 zygapophyseal joints) could produce pain relief through the stimulation of large-diameter fibers that inhibit the transmission of pain[31, 40]. Additionally, it is possible that thoracic manipulation could lead to a decrease in pain owing to the activation of descending inhibitory mechanisms, resulting in a hypoalgesic effect in the distant areas by influencing the dorsal periaqueductal grey region (dPAG)[21, 29].

A statistically significant difference was observed in the current study in favor of the thoracic manipulation in combination with the Rungthip massage technique group, who reported a greater reduction in pain at rest than those who received thoracic manipulation only after three weeks of bi-weekly treatment sessions. This finding may relate to the characteristics associated

**Table 1.** Baseline demographic data and clinical characteristic for both groups[a]

| Variables | Thoracic manipulation (n=14) | Thoracic manipulation plus Rungthip massage technique (n=15) | p-value[b] |
|---|---|---|---|
| Age (years) | 23.27 ± 4.5 | 23.07 ± 2.71 | 0.884 |
| Gender; n of female (%) | 11 (73.33) | 11 (73.33) | 1.000 |
| Height (cm) | 163.67 ± 8.85 | 163.6 ± 8.34 | 0.983 |
| Weight (kg) | 61.6 ± 16.41 | 57.25 ± 11.66 | 0.410 |
| Duration of neck pain (months) | 14.13 ± 11.77 | 11.13 ± 14.27 | 0.535 |
| Pain intensity at rest (VAS; mm) | 45.29 ± 11.53 | 42.33 ± 7.72 | 0.453 |
| Elbow extension ROM (º) | | | |
| Threshold level; P1 | 126.64 ± 19.15 | 115.77 ± 16.78 | 0.284 |
| Tolerance level; P2 | 146.57 ± 16.87 | 139.53 ± 21.99 | 0.359 |

[a]Values are mean ± standard deviation; [b]p-value for paired t-test.

**Table 2.** Mean (standard deviation) of pre- and post-intervention values and within-group differences in both groups[a]

| Variables | Single thoracic manipulation (n=14) | | | Single thoracic manipulation plus Rungthip massage technique (n=15) | | |
|---|---|---|---|---|---|---|
| | Pre | Post | p-value[b] | Pre | Post | p-value[b] |
| Pain at rest (VAS; mm) | 45.29 ± 11.53 | 20.71 ± 12.37 | 0.000** | 42.33 ± 7.72 | 9.67 ± 6.52 | 0.000** |
| Elbow extension ROM (º) | | | | | | |
| Threshold level; P1 | 126.64 ± 19.15 | 135.29 ± 17.14 | 0.003* | 115.77 ± 16.78 | 131.50± 10.83 | 0.002* |
| Tolerance level; P2 | 146.57 ± 16.87 | 151.54 ± 16.54 | 0.179 | 139.53 ± 21.99 | 147.90± 13.63 | 0.158 |

[a]Values are mean ± standard deviation; [b]p-value for paired t-test; *p-value<0.05; **p-value<0.001.

**Table 3.** Between group comparisons of mean differences from pre- to post-intervention of all outcome measures[a]

| Variables | Thoracic manipulation (n=14) | Thoracic manipulation plus Rungthip massage technique (n=15) | Mean differences (95% CI) | p-value[b] |
|---|---|---|---|---|
| Pain intensity at rest (VAS; mm) | 20.44 | 9.54 | 10.89 (3.11 to 18.69) | 0.004* |
| Elbow extension ROM | | | | |
| Threshold level; P1 | 131.87 | 129.35 | 2.52 (−5.93 to 10.97) | 0.183 |
| Tolerance level; P2 | 148.26 | 148.69 | −0.44 (−9.81 to 8.94) | 0.749 |

[a]Values are mean ± standard deviation; [b]p-value for ANCOVA; *p-value<0.05.

with the Rungthip massage technique, applied using force in the area from the level of the inferior angle of the scapula to the lowest rib covering the area of tension[13, 30)]. A plausible explanation is that the Rungthip massage technique mechanism stimulates type I mechanoreceptors and cutaneous mechanoreceptors[13)], in conjunction with the release of tension in the spinal ligaments (including the dural ligament), thereby leading to an analgesic effect in the cervical spine[41)].

An improvement in elbow extension ROM (neural mechanosensitivity) using ULNT1 was demonstrated in both groups post the intervention. However, patients who received thoracic manipulation in combination with the Rungthip massage technique demonstrated a greater change (recovery) in elbow extension ROM in terms of threshold (15.73°) and tolerance levels (8.32°), both of which surpassed the minimal clinically significant difference of 7.5°[42)]. These values were higher than those recorded for patients who received thoracic manipulation only. Thrust joint manipulation to the zygapophyseal joints in the thoracic spine has been proven to improve physiological function. In addition, it is possible that the Rungthip massage technique, which is performed in the paraspinal area, affects mechanical interfaces at the intervertebral foramen, thus increasing neural tissue mobility and extensibility[41)].

A medium to large effect size was seen in this study regarding neck pain at rest between the thoracic manipulation group and the thoracic manipulation combined with Rungthip massage group. However, the findings from this study may not be applicable to all patients with neck pain, i.e., to those with acute or sub-acute mechanical neck pain. Future studies should investigate the long-term outcomes of thoracic manipulation and the Rungthip massage technique for the management of patients with chronic mechanical neck pain.

Thoracic manipulation, directed at the T6/T7 zygapophyseal joints, in combination with the Rungthip massage technique, decreased neck pain at rest and reduced neural mechanosensitivity in participants with chronic mechanical neck pain in this study. The benefits were elevated in participants who received the dual intervention compared to those who received thoracic manipulation only. Thus, the use of the Rungthip massage technique, in conjunction with thoracic manipulation, is recommended as an alternative therapy when treating patients with chronic mechanical neck pain.


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### *Conflict of interest*

The authors have no other financial disclosures and conflict of interest to report.

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