Review Paper: Effectiveness of Thoracic Manipulation on the Treatment of Patients With Mechanical Non-Specific Neck Pain

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ABSTRACT

Introduction: Non-specific mechanical neck pain is a common musculoskeletal complaint that is generally treated conservatively using electro/thermal therapeutic agents, exercise, soft tissue techniques, and manual therapy. In this review, we evaluated the effectiveness of Thoracic Manipulation (TM) compared to cervical manipulations, multi-level TM with single-level TM, and TM with other interventions such as electro/thermal therapy and exercise.

Material and Methods: PubMed, Google scholar and PEDro database were searched from inception until May 2016 by the following keywords: “neck pain”, “thoracic manipulation”, “physical therapy treatment”, “cervical manipulation”, and different combinations. Quality of the included studies were evaluated using physiotherapy evidence database [PEDro] scale.

Results: A total of 15 studies out of 47 based on PEDro score were included in this review. All studies measured pain intensity as a parameter indicating effectiveness of interventions, 9 studies measured disability as a key outcome and used either NDI or NPQ for its assessment.

Conclusion: Thoracic manipulation is equally effective as cervical manipulation in reduction of pain and improving function. Thoracic manipulation is also more effective than electrotherapy or exercise therapy alone. When combined with multimodal neck program, thoracic manipulation for patients with neck pain significantly improves function and reduces pain intensity.

1. Introduction

Neck pain is a common problem among general adult population that can cause limitation of their daily activities and absence from work. It incurs a high economic burden [1-4]. Neck pain affects women more than men with the highest prevalence in middle ages. Lifetime prevalence of cervical pain varies between 14.2%-71.0% with mean of 48.5% [5, 6].

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Non-specific neck pain is defined as pain in cervical region without pathogenic and/or pathognomonic signs and symptoms [6, 7]. There are two basis for non-specific neck pain, postural or mechanical; neck pain due to an unrecognizable pathoanatomic origin is classified as mechanical neck pain [6]. Optimal management of neck pain is a key priority due to its high cost for society [8]. Mechanical neck pain is often treated conservatively and its management consist of both therapeutic and aeromedical decisions [9, 10]. Physical therapy intervention is a common approach for alleviation of cervical region pains [11].

Physical therapists use a wide variety of interventions such as electro/thermal therapeutic agents, exercise therapy, soft tissue techniques and manual therapy in the treatment of mechanical neck pain [12]. Manual therapy, including joint manipulation techniques, is commonly used for managing mechanical neck pain. Joint manipulation is a high velocity low amplitude thrust applied at or near the end range of a targeted segment and is often associated with an audible click [13, 14]. Recent studies support effectiveness of manual therapies in improving pain along with cervical active range of motion and function [6, 15-17]. The exact mechanisms underlying the effectiveness of manipulation is not known yet. However, recent evidence demonstrates various theories supporting its use [18]. Most of these theories state that manual therapy can result in temporary biomechanical changes [19, 20], local and regional neurophysiological effects [21, 22], and changes in the inflammation process that is initiated by injury [23]. Treatment for patients with mechanical neck pain are also influenced by a placebo effect wherein positive expectations play an important role in the final outcome [24, 25].

Cervical Thrust Manipulation is an effective form of manual therapy that can alleviate pain and improve cervical range of motion [17, 26-30], but it can also lead to rare but severe complications related to vertebral artery injury [31-36]. To avoid this potential risk, indirect techniques aimed at the thoracic spine such as Thoracic manipulation Thrust (TM) are often used by therapists in the management of mechanical non-specific neck pain [37]. The aim of this review is to evaluate the effectiveness of thoracic manipulation in treating the patients with mechanical non-specific neck pain.

2. Materials and Methods

Identification of studies

The related articles were searched in PubMed, Google scholar, and PEDro databases from inception till May 2016 by the following keywords: “neck pain”, “thoracic

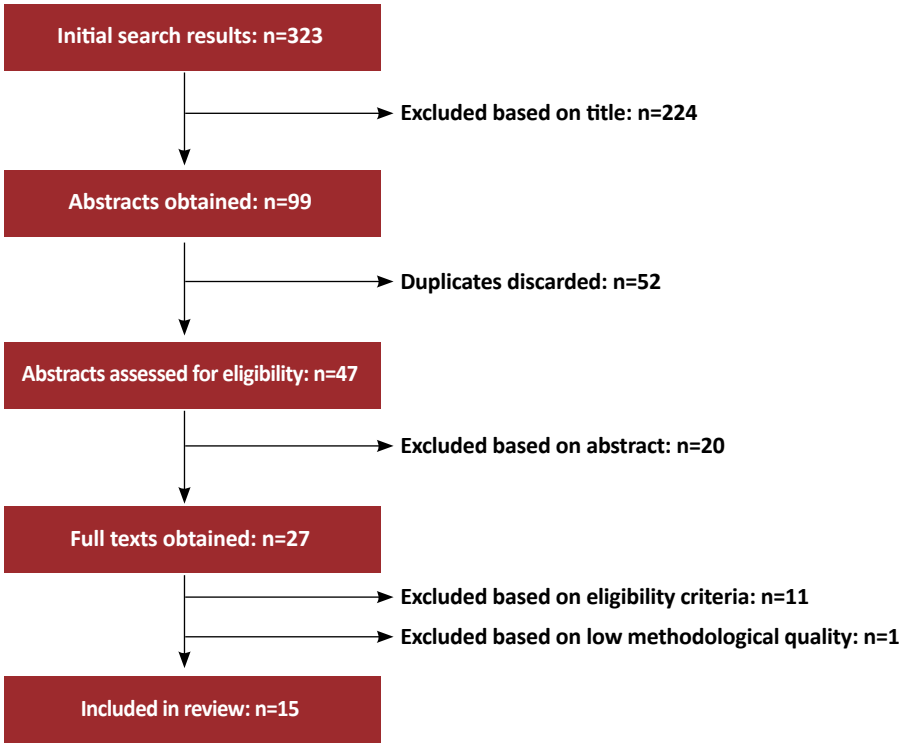

Figure 1. Flowchart for study selection

manipulation", "physical therapy treatment", "cervical manipulation", and their different combinations. The references of identified articles were also checked.

Selection of studies

The review authors independently screened the search results by reading titles and abstracts. Full texts of potentially relevant papers were obtained and assessed for inclusion. Inclusion criteria consisted of randomized control trial studies written in English investigating mechanical non-specific neck pain. All articles used thoracic manipulation as a treatment order were included. Researchers eliminated studies that were not written in English, assessed or treated specific neck pains with additional symptoms such as radiculopathy, headache or whiplash injury, did not evaluate pain, disability and/or range of motion as measurement parameters, or preformed manipulation on places other than thoracic and cervical regions. Search flow diagram for the selection of included studies is shown in Figure 1.

Quality assessment

Two review authors (S.M and H.S) independently evaluated the quality of included studies using physiotherapy evidence database [PEDro] scale that consists of 11 items [38]. Studies scoring 7 or higher were considered methodologically to be of "high" quality. Studies with PEDro scores 5 or 6 were considered to be of "fair" quality, while studies scoring 4 or below were felt to be of "poor" quality [39].

3. Results

Data extraction

The abstracts of 47 studies were assessed for eligibility. A total of 31 studies were eliminated because they did not match the inclusion criteria. A total of 16 studies were evaluated for methodological quality.

Table 1. PEDro scoring of included studies

Authors	1	2	3	4	5	6	7	8	9	10	11	Total Score
Lee et al. [40]	0	1	0	1	0	0	1	1	0	1	1	6/10
Puntumetakul et al. [41]	1	1	0	1	0	0	1	1	1	1	1	7/10
Yang et al. [42]	1	1	0	0	0	0	0	1	0	1	1	4/10
Pires et al. [43]	1	1	1	1	0	0	1	1	0	1	1	7/10
Samannaaz Khoja et al. [1]	1	1	1	1	0	0	1	0	1	1	1	7/10
Salom-Moreno et al. [44]	1	1	1	1	0	0	1	1	1	1	1	8/10
Casanova-Mendez et al. [7]	1	1	1	1	0	0	1	1	1	1	1	8/10
Saavedra-Hernandez et al. [28]	1	1	1	1	0	0	1	1	1	1	1	8/10
Martinez-Segura et al. [45]	1	1	1	1	0	0	1	1	1	1	1	8/10
Puentedura et al. [27]	1	1	1	1	0	0	1	0	1	1	1	7/10
Lau et al. [46]	1	1	1	1	0	0	1	1	1	1	1	8/10
Cleland et al. [47]	1	1	1	1	0	0	1	1	1	1	1	8/10
Gonzalez-Iglesias et al. [48]	1	1	1	1	1	0	1	1	0	1	1	8/10
Gonzalez-Iglesias et al. [49]	1	1	1	1	0	0	1	1	0	1	1	7/10
Cleland et al. [50]	1	1	1	1	0	0	1	1	1	1	1	8/10
Cleland et al. [51]	1	1	1	1	1	0	1	0	1	1	1	8/10
Cumulative score out of 16 studies	16	17	14	16	2	0	15	14	12	17	17	7.3/10

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Criteria satisfied: 0: Criteria not satisfied; 1: Eligibility criteria; 2: Random allocation; 3: Concealed allocation; 4: Similar baseline; 5: Blind participants; 6: Blind therapists; 7: Blind assessors; 8: At least one key outcome were obtained from more than 85% of the subjects; 9: Intention-to-treat analysis; 10: Between group comparison; and 11: Point and variability measures.

When scoring the internal validity of studies, the first item is eliminated because it measures external validity and so the total score is out of 10.

Quality evaluation

PEDro score of 16 remained studies ranged from 6 to 8, indicating "fair" to "high" quality with an average PEDro score of 7.3/10, as detailed in Table 1. Fourteen studies ranked as "high" quality, one ranked as "fair" and one as "poor." The one study with poor quality was eliminated from the review. A total of 15 studies were included in the review. Three criteria of randomization, comparison between groups, and measures of variability were satisfied in all included studies. None of studies met the criterion of blinding of treating therapist.

Characteristic of studies and outcome measures

All 15 studies used thoracic manipulation for the treatment of at least one of the experimental groups. All studies measured pain intensity as a parameter indicating effectiveness of interventions, 9 papers used VAS to assess pain levels before and after treatment while 6 remaining used NPS or NPRS to evaluate pain intensity. Nine studies measured disability as a key outcome and used either NDI or NPQ for its assessment. Characteristics of included studies are summarized in Table 2.

4. Discussion

Thoracic manipulation versus placebo

There is a noticeable increase in studies evaluating the clinical effectiveness of thoracic spine Thrust Manipulation in the treatment of patients with mechanical neck pain in recent years [52]. Cleland et al. compared the effectiveness of thoracic manipulation in which patients were randomized to either one session of thoracic manipulation or sham manipulation. Based on their study, thoracic spine manipulation caused immediate reduction of pain in patients with a primary complaint of neck pain [51]. According to results of recent high quality studies, thoracic manipulation thrust perceptibly improves neck disability, pain intensity, and resting pain intensity in patients with chronic mechanical neck pain [41].

Pires et al. assessed the immediate and short-term effects of upper thoracic spine manipulation on pain intensity in young women with chronic neck pain. Their study did not show any clinically significant difference in resting pain intensity immediately after one session of manipulation therapy or in short-term follow up between experimental group and placebo. The authors mentioned that the absence of significant results in their study may have been due to the mild baseline levels of neck pain intensity among the participants [43].

Although many patients experience a significant benefit when treated with Thrust Manipulation, it is still unclear which patients benefit the most. Ssavedra-Hernández et al. identified several potential prognostic clinical factors, including pain intensity greater than 4.5 points, cervical extension less than 46 degrees, hypomobility of T1 vertebra, a negative upper limb tension test, and female sex that may potentially identify patients with mechanical neck pain who will benefit most and respond best to the treatment using manual therapy [53].

Thoracic manipulation: Multi level versus single level

Recent studies indicate that Multiple-level Thoracic Manipulation (MTM) can reduce pain in patients with mechanical neck pain. However, some side effects of spinal manipulative therapy are commonly seen in clinical practice. MTM can also have some adverse effects, including aggravation of symptoms, muscle spasm, stiffness, headache, radiating discomfort, fatigue, dizziness, and nausea in some patients [41]. Due to this adverse effects of MTM, single level thoracic manipulation (STM) was proposed as another option for treatment of mechanical neck pain.

Recent evidence supports the benefits of single level thoracic manipulation on improving mechanical neck pain and cervical range of motion [54, 55]. A recent study by Casanova-Mendez et al. compared the effects of two single level thoracic manipulation techniques, Toggle-Recoil and DogTechnique, in patients with chronic mechanical neck pain. They evaluated self-reported neck pain, pressure pain threshold and cervical mobility before intervention, immediately, and 20 minutes after intervention. Result of their study showed that both techniques significantly improved pain, pressure pain threshold, and ROM [7].

Puntumetakul et al. evaluated the short-term effects of STM at T5-T6 level and MTM, and concluded that both STM and MTM significantly and almost equally improved neck disability and resting pain intensity in patients with chronic mechanical neck pain, for up to 1 week [41]. These results present a high possibility that patients with mechanical neck pain will experience improvements in pain and range of motion in response to STM while experiencing a lower risk of adverse effects than MTM. 4.3 Thoracic Manipulation versus Cervical Manipulation and other Manual Therapy Techniques

Author	Groups and Interventions	Follow-up	Evaluation Criteria	Results	Description
Lee et al. (2016) [40]	G1: Thoracic manipulation+Deep craniocervical flexor training G2: Deep craniocervical flexor training G3: Active self ROM (control)	-	Pain Disability Cervical & Thoracic ROM Strength and endurance	G1>G2>G3 VAS G1>G2>G3 NDI G1>G2>G3 cervical and thoracic ROM G1>G2>G3 strength and endurance of the deep flexor muscles	All three groups showed improvements in all measured variables.
Punrumetakul et al. (2015) [41]	G1: Single level thoracic manipulation, n=16 G2: Multi level thoracic manipulation, n=16 G3: Prone lying (Control), n=16	24 Hour 1 Week	Pain Disability Cervical-ROM	G1=G2>G3 NDI G1=G2>G3 VAS No significant improvement in Cervical ROM in 3 groups	G1 and G2 demonstrate significant improvement in NDI and VAS.
Pires et al. (2015) [43]	G1: Upper thoracic manipulation G2: Sham manipulation (placebo)	48 & 72 Hours	Pain G1=G2 Myoelectric activity of SCM	G1=G2 VAS G1=G2 Myoelectric activity of SCM	No statistically significant differences were found in the intergroup analysis of G1 and G2 group after treatment regarding myoelectric activity of the cervical muscles or the intensity of neck pain.
Khoja et al. (2015) [1]	G1: Multi modal neck program+Thoracic manipulation, n=11 G2: Multi modal neck program, n=11	6 Weeks	Pain Disability Cervical-Active ROM GROC*	G1>G2 NPS G1=G2 NDI	Both groups experienced clinically important improvement in NDI outcomes. *GROC: Global Rating Of Change
Salom Moreno et al. (2014) [44]	G1: Thoracic manipulation, n=27 G2: Thoracic mobilization, n=25	-	Pain intensity Pressure pain threshold	G1>G2 NPS G1=G2 PPT	Both groups demonstrate reduced pain and increased PPT after treatment.
Casanova-Méndez et al. (2014) [7]	G1: Thoracic manipulation dog technique, n=30 G2: Thoracic manipulation toggle-recoil technique, n=30	20 Minutes	Neck pain C-ROM Pressure pain threshold	G2=G1 NPRS G2>G1 NDI G1=G2 PPT	Pain, neck mobility, and mechanosensitivity improved in both groups but only G2 had statistical inter-group significance in all outcome variables.
Saavedra-Hernandez et al. (2013) [28]	G1: Cervical manipulation, n=41 G2: Cervical manipulation+Thoracic manipulation, n=41	1 Week	Pain Disability ROM	G2=G1 NPRS G2>G1 NDI G1=G2 C-ROM	Both groups experienced similar improvements in cervical range of motion and neck pain.

Author	Groups and Interventions	Follow-up	Evaluation Criteria	Results	Description
Martinez-Segura et al. (2012) [29]	G1: Cervical thrust manipulation on the right, n=30 G2: Cervical thrust manipulation on the left, n=30 G3: Thoracic manipulation, n=30	-	Pressure pain threshold Neck pain C-ROM	G1=G2=G3 PPT G1=G2=G3 VAS G1=G2=G3 C-ROM	All three groups experienced similar bilateral statistically significant increase in PPT. All three groups improved in pain levels and cervical ROM but the difference was not statistically significant.
Lau et al. (2011) [46]	G1: Thoracic manipulation+education, IR G2: Education, IR	3 & 6 Months	Pain Disability ROM Cranio-vertebral angle Health-related quality of life status	G1>G2 NPRS G1>G2 NPQ G1>G2 cervical ROM G1>G2 CV angle G1>G2 SF36	Both groups showed improvement in NPRS right after treatment but it didn't last till 6 month follow up. Both groups reported a decrease in NPQ which last till 6 month follow up Both groups showed improvement in ROM. The CV angle was increased in both groups that lasted till 6 month follow up. Both groups demonstrate increase in health-related quality of life status 6-months post treatment.
Cleland et al. (2010) [47]	G1: Thoracic manipulation+cervical mobility and strength exercise, n=70 G2: Cervical mobility and strength exercise, n=70	1 & 4 Week 1 Month	Pain Disability	G1>G2 NPRS (1 Week follow up) G1>G2 NDI (1 month follow up)	Both groups showed significant improvement in NDI and pain levels.
Gonzalez-Iglesias et al. (2009) [48]	G1: Thoracic manipulation+TENS, n=23 G2: TENS, n=22	2 & 4 Weeks	Pain Disability ROM	G1>G2 VAS G1>G2 NPQ G1>G2 active ROM	Both groups showed significant improvement in NDI, ROM and pain levels.
Gonzalez-Iglesias et al. (2009) [49]	G1: Thoracic manipulation+TENS n=23 G2: TENS, n=22	2 & 4 Weeks	Pain Disability ROM	G1>G2 VAS G1>G2 NPQ G1>G2 Active ROM	Both groups showed significant improvement in NDI, ROM and pain levels.
Cleland et al. (2007) [50]	G1: Thoracic spine thrust mobilization/manipulation, n=30 G2: Thoracic spine none thrust mobilization/manipulation, n=30	2 & 4 Days	Pain Disability FABQ GROC	G1>G2 NPRS G1>G2 NDI G1>G2 FABQ & GROC	Both groups experienced improvement in Pain and disability, thoracic Thrust Manipulation group demonstrate better results and fewer side effects. *FABQ: Fear Avoidance Beliefs Questionnaire.
Cleland et al. (2005) [51]	G1: Thoracic manipulation, n=19 G2: Placebo, n=17	-	Pain	G1>G2 VAS	G1 Had significant pain reduction.

While being widely used and effective in reduction of pain, cervical manipulation can be associated with minor adverse effects, such as local discomfort, headache, dizziness, nausea, or serious complications such as radiculopathy, myelopathy, and stroke. The most important complication is the possibility of damaging the vertebrobasilar artery [35]. The incidence of vertebrobasilar artery injury with cervical manipulation is one in every two million cervical manipulations [11]. Odds of cerebrovascular accidents after cervical manipulation are unpredictable, so with regard to the risks of cervical manipulation, thoracic spine manipulation was considered as an alternative method for treating the patients with mechanical neck pain [51, 56].

Two Randomized Control Trial (RCT) studies compared the effectiveness of a thoracic Thrust Manipulation (TM) with Cervical Thrust Manipulation (CM) with regard to improvement of pain, disability, and Range of Motion (ROM) in patients with mechanical neck pain. The result of both studies demonstrate that cervical and thoracic Thrust Manipulations were equally effective in reducing pain and improving disability and ROM in patients with neck pain, but one study states that in comparison with cervical manipulation, thoracic manipulation was more effective [45], while the other found cervical manipulation to be the superior intervention [27]. According to a recently published systematic review, TM and CM are both equally effective. However, lack of studies attempting a direct comparison between thoracic and cervical manipulation, as well as the limited long-term follow up in existing trials, prevents to reach a decisive conclusion about whether cervical or thoracic manipulation is the superior intervention for managing mechanical neck pain [11].

One high quality RCT compared the effectiveness of thoracic spine thrust mobilization/manipulation with non-thrust thoracic mobilization/manipulation in patients with a primary complaint of mechanical neck pain. They assessed pain, disability, fear-avoidance beliefs, and global rating of change in 60 patients receiving either thoracic thrust or non-Thrust Manipulation/mobilization. The result of their study suggests superior effect of Thrust Manipulation techniques in all outcome measurements [50]. Another high quality RCT compared thoracic spine Thrust Manipulation with thoracic non-thrust mobilization and concluded that thoracic Thrust Manipulation is a better option for alleviation of neck pain and decreasing pressure pain sensitivity in short term [44].

Thoracic manipulation versus exercise

2 RCTs [40, 47], with different qualities ranging from fair to high, used either exercise or exercise plus thoracic manipulation to investigate effectiveness of thoracic manipulation on patients with mechanical neck pain. Recent evidence supports using exercise for alleviating pain and improving dysfunction and disability [1, 27, 40, 47]. In a recent clinical trial, eligible subjects with chronic neck pain were divided into either TM and Deep Craniocervical Flexor (DCF) training group, or craniocervical flexor training alone. Exercise was focused on improving strength and endurance of DCF muscles. After 10 weeks of treatment, the TM plus DCF training group had significantly better results on pain, disability, cervical ROM and even strength and endurance of the deep flexor muscles. This suggests the positive effect of TM when added to an exercise regime for treatment of mechanical neck pain [40].

Cleland also conducted similar trials. They added TM to a more comprehensive exercise program consist of stretching and strengthening exercises, including upper trapezius, scalene, sternocleidomastoid, levator scapulae, pectoralis major and minor stretch, and deep neck flexor training, cervical isometrics, middle and lower trapezius and serratus anterior muscle strengthening exercises. Cleland et al. evaluated pain and disability immediately after 4 weeks of treatment and 1-week and 1-month follow up. They concluded that patients with mechanical neck pain who received thoracic spine manipulation alongside the exercise regime demonstrate significantly greater improvements in disability at both the short-term and long-term follow-up periods and in pain at the 1-week follow-up compared with patients who received exercise only [47].

Thoracic manipulation versus electrotherapy

Gonzalez-Iglesias conducted two clinical trials that compared neck pain, level of disability, and cervical range of motion between two groups of patients with acute neck pain. They randomized participants to either control group that received 6 sessions of electrotherapy and soft tissue massage, or experimental group that received control group's treatment and also a thoracic manipulation. One trial reported treatment effect at 1-week follow-up [48], while the second reported treatment effect at 2-week and 4-week follow ups [49]. Both studies reported clinically significant improvements in pain, ROM, and neck disability with slightly better results in the group receiving thoracic manipulation.

Another trial compared neck pain, disability, mobility, and health-related quality of life status between two groups of participants with chronic neck pain. In this study, patients were randomized to an experimental group who received thoracic manipulation, Infra Red Radiation therapy (IRR), and a standard set of educational material; and a control group who received only IRR and a standard set of educational material. After 8 sessions of intervention, the experimental group showed significantly better improvement with regard to pain, disability, mobility, and health-related quality of life status. TM was shown to be effective in reducing neck pain, improving dysfunction and neck posture, and neck ROM up to 6 months post-treatment [46].

Although previous trials suggested superior benefits of thoracic Thrust Manipulations (TM) on outcomes such as pain, ROM, and disability, it should be noted that these studies compared effectiveness of TM with other interventions that have limited ability in improving neck pain when applied alone. In contrast, Khojaet et al. [1] evaluated the benefits of TM in treatment of mechanical neck pain when applied as a supplement of a multimodal intervention program, including electrotherapy, thermal agents, exercise therapy and non-thrust cervical spine manual therapy. The comparison between Multimodal Neck Program (MNP) and MNP plus TM is more clinically relevant because the current clinical practice among the majority of therapists involves the use of multimodal interventions to maximize treatment efficiency.

Khoja et al. divided 22 patients randomly into two groups. The experimental group received MNP+TM while the control group received MNP only. Pain, disability, ROM, and perceived health were assessed at a baseline assessment session. After 12 treatment sessions, there were no statistically significant clinical benefit in the TM+MNP group in regard to the selected outcome measures. Both groups experienced significant improvements in neck pain, disability, and ROM. The authors stated that the small sample size may limit the ability to detect statistically significant differences between the groups in their study [1].

Due to the potential risk of serious complications associated with cervical manipulation, such as vertebrobasilar artery insufficiency, it has been suggested that non-thrust cervical mobilization or thoracic Thrust Manipulation be used instead of cervical Thrust Manipulation for managing non-specific neck pain. It appears that thoracic manipulation techniques are effective in improving neck pain and function and these improvements are on the same order as the improvements resulting from cervical techniques. Both single-level and multiple-level thoracic manipulation improve neck disability, pain intensity, and cervical range of motion, with STM presenting a lower risk of adverse effects when compared to MTM.

Evidence also supports the enhancements offered by TM in improving pain, disability, and function when used alongside electro/thermal modalities or exercise regimes. However there is as yet no definitive evidence of enhancements when using TM alongside a multimodal neck program (MNP). Given the clinical relevance of this latter comparison, further research on this topic is highly recommended.

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Conflict of Interest

The authors declared no conflicts of interest.

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