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Thoracic Manipulation an Adjunctive Treatment for Neck Pain: Case Study and Literature Review

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Abstract

Background: Neck pain is a prevalent pathology estimated to affect approximately half of the population in a lifetime. There is currently no gold standard for the treatment of neck pain. Physical therapy has shown potential for improved outcomes when used to treat neck pain. The purpose of this report is to evaluate the possible clinical utility of thoracic manipulation as part of a comprehensive physical therapy plan of care with a case study and review of clinical evidence. **Case Study:** A 31-year-old male with a 5-month history of right-sided neck pain presented to physical therapy. His examination revealed significant cervical range of motion (ROM) restrictions, upper thoracic hypomobility and reproduction of symptoms with pressure to his right T3 facet. **Intervention**: The patient was treated with high velocity low amplitude thrusts (HVLAT) that were primarily directed at the cervicothoracic region, and a progressive exercise program. The thoracic HVLAT is performed with an anterior to posterior force application with the mobilizing hand in a pistol grip formation cupping the spinous processes. **Outcomes**: Follow up measures conducted before and after treatment included: Neck Disability Index, Numerical Pain Rating Scale, Craniocervical Flexion Test, Patient Specific Functional Scale, and cervical ROM as measured with CROM inclinometers. After 10 weeks of physical therapy the patient demonstrated improvements in these outcomes beyond their respective Minimally Clinically Important Differences. **Discussion:** Multiple neurophysiological and mechanical mechanisms are proposed for the effect of manipulation, but the exact mechanism is unknown. The outcomes of this case are consistent with the current body of evidence for thoracic manipulation, which while not conclusive, show a trend toward improved outcomes when combined with exercise.

Introduction and Background

Neck pain is a disorder that is not only highly prevalent but also leads to significant long-lasting disability in those afflicted. The estimated mean annual prevalence of neck pain is 37%,[1,2] additional estimates report that half of all people will experience clinical neck pain in their lifetime.[1] Neck pain is the 4th leading cause of disability according to Global Burden of Disease study conducted in 2010.[3] Acute neck pain of 6 weeks or less will resolve by 2 months in most people, however 50% of those that experienced neck pain will have reoccurring symptoms one year after their initial episode.[1] Neck pains' high prevalence, associated disability and lack of gold standard treatment necessitate the utilization of effective evidence-based care for this condition.

Conservative treatment including physical therapy has shown positive outcomes when used to treat this condition, when compared to no active treatment, and has no different outcomes compared to surgery.[4] Physical therapy interventions generally consist of strengthening, stretching and range of motion (ROM) exercises. Additional interventions may include joint mobilization, joint manipulation, soft tissue mobilization, thermal modalities, traction, and electrical stimulation. The combinations of these interventions vary among practitioners and there is currently little consensus on the most effective treatment strategy for patients with neck pain.

Thoracic manipulation is an intervention with a growing body of evidence supporting its clinical utility in the care of neck pain. A physical therapist's individual training and background may lead to the underutilization of this intervention for neck pain.[5] During a recent clinical experience thoracic, cervical and rib manipulations were commonly incorporated in the treatment of neck pain, as part of comprehensive plan of care that also included strength and ROM exercises. One patient that received this therapeutic approach noted significant improvements in pain, cervical ROM, cervical strength, and function.

Decreased thoracic mobility is thought to be one contributing factor of neck pain through regional interdependence. A study by Norlander et. al found a correlation between decreased upper thoracic mobility, specifically at the levels of C7-T2 was predictive of neck pain. This lack of mobility is believed to stimulate the firing of mechanoreceptors in that region, and lead to the symptom of neck pain.[6] This hypomobility provides a possible biomechanical explanation for the effect thoracic manipulation has on the reduction of neck pain. Multiple other neurophysiologic mechanisms are proposed to underline the effects of thoracic manipulation they involve muscle spindle firing, autonomic nervous system and neuroendocrine response.[7-10] During spinal manipulations many times an audible pop or cavitation is heard understanding what happens during this process may provide further information to better understand the physiologic process of manipulation. The purpose of this case study and literature review is to examine thoracic manipulation as an adjunctive therapy in the treatment of neck pain.

Case study

A 31-year-old male presented to an outpatient physical therapy clinic for the treatment of neck pain in the summer of 2017. (Note, the patient provided verbal consent to use his medical information for the purpose of this case report.)

His symptoms of right-sided neck pain, numbness and tingling down to the thumb, but no pain past elbow began in late 2016 after the patient reported he woke up with a "crick in his neck". The patient has a history of two major car accidents within the last 3 years, one he was ejected from the vehicle and the other the vehicle rolled over. The patient works in pest control in which he spends much of his day driving to his clients. He had an MRI conducted after the onset of his symptoms, but prior to physical therapy examination. The MRI revealed multilevel disc degeneration and mild disc bulges. The patient had previously seen a chiropractor who performed a cervical manipulation, but the patient experienced no relief of symptoms. All significant specific examination findings are listed in Tables 1 and 2. General examination findings included ROM restrictions, joint hypomobility throughout upper thoracic and lower cervical spine, and reproduction of patient's symptoms with pressure to his T3 facet. These findings led to clinical diagnoses of neck pain, T3 facet dysfunction, and upper thoracic hypomobility.

On the day of the evaluation, an experienced clinician performed multiple High Velocity Low Amplitude Thrusts (HVLATs) to the cervical, upper thoracic spine, and ribs however he was unable to produce a cavitation at the level suspected to be most problematic. The HVLAT technique to the thoracic region was applied with an anterior to posterior force with the therapists mobilizing hand in a pistol grip formation see Figure1. A home exercise program was also provided which included supine chin tucks, chin tucks with active cervical rotation, and thoracic lifts.

Figure 1. Hand position for thoracic manipulation

Over the course of 10 weeks, this patient was seen for a total of 10 visits, 1 hour per visit, 1-2 times most weeks, but the patient took two one-week long vacations during his care. Initially, the focus of the treatment was to reduce pain and promote cervical and thoracic mobility. This was accomplished through HVLAT manipulation, manual stretching, self-stretching, and active range of motion exercises. HVLATs were directed toward upper thoracic, cervicothoracic junction, and ribs 1-3. During the first 3-4 therapy sessions creating a successful manipulation to the patient's area of greatest restriction, right T3 facet, and costotransverse junction, was difficult due to the severity of thoracic restriction.

Standard practice for this clinician would be to refrain from performing manipulation after the first couple treatments and focus on active strength and ROM exercises. In this case, the patient was very stiff and successful manipulation was not easily achieved. About half-way through 10 weeks of treatment, a half foam roll wedge was used by the clinician support his mobilizing hand when performing an anterior to posterior thoracic and upper rib HVLAT. This modification helped to achieve a cavitation and successful manipulation to the area previously determined to have the greatest restriction. Up until this point, the patient had reported mild improvement in symptoms with a couple exacerbations after engaging in strenuous activity, such as lifting a dresser.

After this successful manipulation, the patient reported steady improvements in pain and symptoms and did not report any further exacerbations. As the patient's symptoms improved the plan of care began to focus more heavily on scapulothoracic strengthening, upper extremity strengthening, and core stabilization. Additionally, postural education was provided to help reduce forward head and rounded shoulders position, especially while the patient was driving. Chin tucks, scapular retraction and depression exercises were particularly emphasized to combat this posture. By the end of the 10-week treatment interval, the patient no longer complained of any neck pain, just occasional stiffness. The patient had significant improvements in ROM, deep neck flexor strength, and neural tension symptoms (significance determined by MCID values in Table 3). At this point, the patient was able to perform more strenuous overhead exercises without pain or limitation. Upon the conclusion of treatment, the patient was provided a more advanced home program that he could continue to improve with self-guided care. In this case, thoracic manipulation was a well-tolerated intervention and in combination with strength and ROM exercises may have contributed to the clinical significant improvements the patient experienced over a 10-week course of physical therapy.

Outcome measures commonly associated with neck pain and function include: neck disability index (NDI), numerical pain rating scale (NPRS), visual analog scale (VAS), fear avoidance beliefs questionnaire (FABQ), Craniocervical flexion test (CCFT), and goniometric measures of cervical range of motion (ROM). Many of these are utilized throughout current literature regarding outcomes of interventions for neck pain. Nearly all of these outcomes were used to determine significant improvement in the patient case. These clinically imported differences are listed in Table 3. Of these outcome measures, most are commonly used in the physical therapy practice except the craniocervical flexion test which will be discussed in further detail.

Table 1. Pre-vs Post Outcome Measures.

Objective Test	Initial Evaluation	Final Re-Evaluation
NDI	36/50	8/50
Pain	6/10	0/10
FABQ	32	NT
CCFT	(+)	(-)
Spurling	(+)	(-)
ULNT Median	(+)	(-)
PSFS: Can perform static and dynamic activities without pain or limitation	0/10	9/10

*****NDI-Neck Disability Index, FABQ-Fear Avoidance Beliefs Questionnaire, CCFT-Craniocervical Flexion Test, UNLT-Upper Limb Neural Tension, PSFS-Patient Specific Functional Scale

Table 2. Pre Vs. Post Cervical ROM Measures.

Cervical Range Direction	Initial Evaluation	Final Re-Evaluation
Flexion	20	58
Extension	24	68
Right side bending	38	50
Left side bending	28 p!	42
Right rotation	60 p!	80
Left rotation	50 p!	80

*ROM-Range of Motion, p!-Pain

Table 3 Clinical Significance.

Outcome Measure	MCID	MDC	SEM
NDI (0-50)	3.5-7.5	8.4-10.5	3-8.4
NPRS (0-10)	2	3	1.02
CCFT			6.7%-10.3 %
Cervical goniometry		5.4-9.6 degrees	2.5-4.1 degrees
PSFS (0-10)	1.2-1.35	2	.43

*****MCID-Minimally Clinically Important Difference, MDC-Minimal Detectable Change, SEM-Standard Error Measurement. NDI-Neck Disability Index, NPRS-Numerical Pain Rating Scale, CCFT-Craniocervical Flexion Test, PSFS-Patient Specific Functional Scale [12-17]

Craniocervical Flexion Test

The craniocervical flexion test is a tool used to measure a person's ability to contract deep neck flexors muscles specifically longus coli and longus capitus. These muscles are commonly found to be dysfunctional in patients with neck pain. Therefore, a tool that can measure the activation of these muscles can be useful in determining the success of a treatment protocol targeting deep neck flexor neuro re-education and strengthening. This test utilizes a pressure sensitive biofeedback cuff placed just below the patient's occiput. The cuff is inflated to 20 mm Hg while the patient is at rest. The patient is then instructed to perform a subtle chin tuck such that the back of their neck begins to press against the inflated cuff. The patient is instructed to press until 2 mm Hg rise in pressure and hold for 10 seconds. The patient then increases pressure another 2 mm Hg and holds for another 10 seconds. A successful test is achieved once the patient has completed this process 5 times resulting in 30 mm Hg pressure during the final 10 sec hold.[15]

Figure 2. Biofeedback cuff used for CCFT.
Image from: www.amazon.com

Another common test for deep neck flexor strength is craniocervical flexion with a head lift. The activation of deep neck flexors compared to superficial neck flexors was compared between the CCFT and this head lift test using intra pharyngeal suction electrodes. They found an equal percent activation of maximal voluntary contraction of deep neck flexors between the two tests, while the CCFT had less recruitment of superficial neck flexors compared to the head lift test.[15] This finding suggests that the CCFT may be more sensitive to deep neck flexor impairment, compared to that of a head lift test, in which impairment may be masked by superficial cervical flexors.

The clinic at which the case study was performed utilized a modified version of the CCFT which had patients displace 10 mm Hg for 10 seconds 10 consecutive times with a short 1-2 second rest break in between each repetition. This test was considered pass or fail, and a number of correct repetitions was not recorded. If patients were unable to complete the test they were considered positive for the CCFT test. A few subjective difficulties with the test can be obtaining a consistent baseline pressure value because every time a patient moves slightly, or changes position the cuff subsequently changes pressure. Positioning the dial in a way such that the therapist and the patient can read without creating accessory head motion by the patient can be difficult. These added variables make performing the test especially difficult when attempting to maintain 2 mm Hg changes. These practical variables were part of the reason a modified version of this test was applied in the clinic.

Neurophysiology

What happens with the pop? This is a question that many patients have after a manipulation is performed. Numerous theories have previously been proposed to explain this phenomenon, including the rapid formation of a gaseous bubble, the rapid collapse of a bubble, ligamentous recoil, and tribonucleation.[18] "Tribonucleation is a known process where opposing surfaces resist separation until a critical point where they separate rapidly resulting in vapor cavities that do not collapse instantaneously. "Originally described by Roston and Wheeler Haines.[18,19] A recent study addressed this question using real-time MRI imaging of the cavitation process that occurs with the distraction of a metacarpal-phalangeal joint. They found that the process of tribonucleation seemed to best fit the observation of the real-time visualization of joint cavitation.[18]

During a cavitation, the pop occurs when the viscous and adhesive resistance of the opposing joint surfaces is overcome by the applied load and there is a rapid formation of a CO2 bubble in the joint, that does not spontaneously resolve until joint surfaces are reapproximated. The rapid formation of the CO2 bubble is what corresponds to the audible pop. This process is similar to the theory of the rapid formation of the gaseous bubble, although it was previously believed the bubble would remain for a period of time after the joint was reapproximated which is not the case.[18] This process of joint cavitation is now better clarified, however the mechanism by which thoracic manipulation may provide clinical improvements is not yet completely understood.

One of the more highly thought of proposed mechanisms for thoracic manipulation is its effect on muscle spindle activity. Numerous studies have found changes in neural input arising from co-activated paraspinal and multifidi sensory receptors.[7,9] A recent study conducted in cats utilized a mechanical form of High Velocity Low Amplitude-Spinal Manipulation (HVLA-SM) directed at two different lumbar segments to determine if the location of thrust force had an impact on muscle spindle activity. They found there was no difference in muscle spindle activity when the thrust force was directed at the lamina, spinous process, or mamillary process within the same vertebrae. The muscle spindle activity at the targeted vertebrae was significantly greater than the activity of the vertebrae adjacent to the targeted site.[7]

Other significant findings from this study were that muscle spindle activity significantly decreased below resting baseline following HVLA-SM with no difference in contact sites noted. Also, there was a decrease in muscle spindle responsiveness to movement following HVLA-SM. If the threshold for muscle spindle response is lowered this lessens the input to the nervous system which may result in a subthreshold pain response.[7] These findings suggest that muscle spindle firing decreases following manipulation which may result in part to a therapeutic reduction in pain.

A neuroendocrine response to thoracic manipulation was recently studied in healthy men by Mani, Botnmark, and Sampath.[10] They measured salivary cortisol, testosterone, and the testosterone cortisol ratio (T/C ratio) as a measure of hypothalamic pituitary response before and after manipulation. In addition, measures of oxyhemoglobin, and heart rate variability were assessed following thoracic manipulation. Their significant findings included a drop in cortisol levels 5 minutes after manipulation and a significant drop in T/C ratio 6 hours post thoracic manipulation. The implication of these findings suggests as previously reported an increase in sympathetic excitation and prolonged neuroendocrine response. Cortisol can have widespread effects on glucose, fat, and protein metabolism and can stimulate gluconeogenesis, which can be used as a building block of tissue repair. Therefore, this study provides some preliminary evidence that thoracic manipulation alters hypothalamic pituitary function in a way that may promote tissue healing.[10] However, tissue healing is a multifactorial process thus it would be a vast oversimplification to imply a cause and effect relationship from this study alone.

Other proposed biomechanical mechanisms to produce the therapeutic effect of spinal manipulation include releasing of trapped mensicoids, releasing adhesions, and restoration of biomechanical buckling of facets.[9] No studies could significantly justify these mechanisms. Another theory proposes that the mechanical overload of manipulation alters the sensory process to the nervous system and may alter nociceptive firing and reduce silent nociceptive firing. This could provide significant pain reduction.[9,20] No single theory is able to sufficiently explain the therapeutic effect of thoracic spinal manipulation, there is increasing evidence to support the possible effect on muscle spindle activity and neuroendocrine modulation.[7,10]

Safety

Thrust manipulation is generally considered to be a safe treatment by many clinicians in the fields of physical therapy and chiropractic. Although, there is little evidence evaluating the safety of thoracic thrust manipulation. One systematic review attempted to answer this question. In their search of published, peer reviewed articles, reporting adverse events associated with thoracic manipulation between 1950-2015, they only found 7 case reports citing a total of 10 adverse events associated with thoracic manipulation.[11] Out of these 10 adverse events, only one was conducted by a physical therapist. All of the reports were published by a clinician dealing with the adverse event rather than the clinician performing the manipulation. It is not clear if the patients presenting with these adverse events displayed symptoms of insidious pathology prior to manipulation that could have been screened and excluded from this list. Additionally, it was also not clear what technique was used to perform the manipulation which may or may not influence relative risk. To minimize any possible risk, it is essential to adequately screen a patient prior to manipulation.[11] A Full list of precautions and contraindications can be seen Tables 4 and 5 below.

Conversely, cervical manipulation has been studied in greater detail in terms of adverse events. In general, cervical manipulation is considered to have a greater risk with one of the largest concerns being vertebral artery dissection. One study compared the adverse events of NSAIDs vs cervical manipulation for the treatment of neck pain. They determine that NSAIDs by a factor of several hundred times, had a greater associated risk for serious death or injury when compared to that of cervical manipulation.[21] This comparison provides a good indicator for the relative risk associated with manipulation in general. Accordingly, adverse events can happen with thoracic joint manipulation, but are even more rare or unreported compared to cervical manipulation.

Clinical Evidence

There is a growing body of clinical evidence for the use of thoracic manipulation for neck pain. Multiple systematic reviews and RCTs have found benefits of pain reduction, self-reported function, and ROM improvements.[22-26] However, due to the lack of quality studies and heterogeneity of the literature, the consensus is that thoracic manipulation may be beneficial, but the quality is not yet high enough for generalizability. The conclusions of systematic reviews regarding neck pain also vary. One systematic review found no sufficient evidence that thoracic spine manipulation has a greater effect than control interventions for non-specific neck pain. While other reviews have found therapeutic utility for the use thoracic manipulation in patients with mechanical neck pain and non-specific neck pain.[24,25] Some of this inconsistency may be due to various RCT methods including the participant inclusion criteria and what manipulative therapy was compared against. Due to this heterogeneity, this report will highlight several individual studies that most closely matched the patient and manipulative technique in the previously discussed case report.

Using thoracic manipulation that most closely resembled the type of care provided in this case study, Kim and Lee et. al compared three treatment groups, manipulation plus deep craniocervical strengthening to deep neck craniocervical flexor strengthening alone and active self-exercise with no manipulation or targeted exercises.[22] Participants had chronic mechanical neck pain of at least 3 months, limited craniocervical flexion and extension ROM, were between the ages 18-60, and had an NDI of >20%. Participants were excluded if they had pain of vascular or neurological system origin; neurological deficits, including nerve root signs; spinal stenosis; previous craniocervical or thoracic spine surgery; or receipt of spinal manipulation therapy within 2 months prior to the study. Thus, the patient described in this case report would have met these study criteria.[22]

All patients received treatment for 35 minutes a day, 3 days a week, for 10 weeks. Those in the manipulation plus exercise group demonstrated significant improvements in strength and endurance of the deep craniocervical flexor muscles, ROM of the cervical spine, pain (VAS), and disability (NDI) compared to those only receiving targeted exercise, but no manipulation. Further, both targeted exercise groups (with and without manipulation) showed greater improvements than the self-directed exercise group ($p<0.05$).[22] This demonstrates that while craniocervical flexor strengthening alone was more beneficial than no targeted treatment, when combined with thoracic spine manipulation, even greater benefits were observed.

A similar study found that thoracic manipulation when combined with targeted stretching and strengthening exercises produced greater improvement in pain and disability, when compared to exercise alone.[23] The primary purpose of this study was to examine the validity of clinical prediction rules for the use of thoracic manipulation, which they concluded were not predictive of patient response to manipulation. As a secondary outcome measure this study's findings supported the use of thoracic manipulation in combination with exercise for the treatment of mechanical neck pain in general. The exercises they used were similar to those chosen for this case report, including manual stretching and strengthening exercises. Stretching of the: upper trapezius, scalene, sternocleidomastoid, levator scapulae, and pectoralis major and minor muscles as well as strengthening of the deep neck flexors, middle and lower trapezius, and serratus anterior.[23]

Two RCTs found conflicting results when comparing thoracic spine manipulation to placebo manipulation.[8,27] For the placebo manipulation, the therapist used a flat hand instead of the normal pistol grip and did not provide a thrust. Cleland et. al found an immediate overall reduction in neck pain while Sillevis et. al did not find a significant reduction in pain response. These differences may have been due to the fact that the mean duration of neck pain in the Sillevis study was over 2 years, but was 12-13 weeks in the Cleland study.[8,27] This suggests that thoracic spinal manipulation may have greater therapeutic effect in acute or subacute neck pain rather than chronic neck pain. Similar conclusions were found in a review of studies using the GRADE criteria, indicating moderate quality evidence supports pain reduction from thoracic manipulation in patients with acute to subacute neck pain. Whereas patients with chronic neck pain had a smaller effect and lower GRADE quality for manipulation, but the intervention still favored the treatment group.[26]

A treatment commonly compared to thrust manipulation is joint mobilization. Multiple systematic reviews and RCTs have compared these two treatments with contradictory results. A 2014 systematic review conducted by Young et. al compared thoracic mobilization vs manipulation for the treatment of neck pain they found considerable evidence, of varied quality, for short-term improvements in neck pain, ROM, and disability from thoracic manipulation.[28] However, no clinical evidence was found to support the use of thoracic mobilization for the treatment of neck pain. Conversely, the systematic review conducted by Gross, Langevin, Sj et.al (2015) found no difference between thoracic mobilization and manipulation for the treatment of neck pain and disability.[26] An Additional finding of this study,[26] and another RCT[29] was that cervical manipulation produced equal to greater outcomes in terms of pain and disability when compared to thoracic manipulation.
Current evidence suggests that at worst thoracic manipulation is no better than mobilization, but may produce more benefits than mobilization. While cervical manipulation may have equal to better outcomes when compared to thoracic manipulation.[26,29] The focus of this report was on thoracic manipulation due to its relative ease of execution, physical therapist comfort, and perceived lower risk of adverse events.

While thoracic manipulation is also used to treat other upper quadrant and back conditions the evidence supporting its use for these conditions is not as strong as for neck pain. Multiple studies have looked at the effect of thoracic manipulation on scapulothoracic kinematics with none able to show a significant effect.[30,31] Other studies have examined the effect of thoracic manipulation on frozen shoulder syndrome; again, no significant benefit was found.[32] However, there is mixed evidence on the effect of thoracic manipulation on shoulder pain, specifically impingement, thus it is not yet clear whether thoracic manipulation may provide some benefit for this condition.

Clinical studies support the use of thoracic manipulation to reduce pain and improve strength, ROM and disability for patients with neck pain when compared to inactive intervention, placebo, thoracic mobilization, and exercise alone.[22-24,26] Thoracic manipulation may have a greater effect on patients with acute or sub-acute neck pain.[26] The best evidence for thoracic manipulation is in combination with exercise where it has a greater benefit than exercise alone.[8,27] Additionally, most of the evidence reports greatest effects in pain reduction immediately after manipulation.[26] Due to the varied quality of

Table 4. Contraindications for thoracic joint manipulation.[11]

Bone Issues
Tumor
Infection
Metabolic
Congenital
Iatrogenic
Traumatic fracture, dislocation
Surgical fusions, recent surgery
Ankylosing spondylitis
Neurological issues
Acute myelopathy
Spinal cord compression
Cauda equina syndrome
Bilateral hyperreflexia, sensory loss sudden vomiting, nausea, vertigo
Vascular compromise
Vertebrobasilar insufficiency
Aortic aneurysm
Bleeding diseases, hemophilia, anticoagulation therapy
Unstable angina
Untreated cardiac insufficiency.
Acute abdominal pain
Lack of therapist skill, patient consent

the literature as well as heterogeneity of the research a definitive generalizable recommendation cannot be made for the use of thoracic manipulation at this time.

Conclusion

Thoracic manipulation with proper screening can be a safe, well tolerated, adjunctive treatment for the management of neck pain. While the exact physiologic mechanisms for manipulation are not completely understood, it is plausible that manipulation may have some effect on muscle spindle signaling, neuroendocrine control, and pain processing.[7-10] Current clinical evidence suggests better clinical outcomes for patients with acute or subacute neck pain.[22-25] The combination of thoracic manipulation with exercise may also improve patient outcomes when compared to exercise alone or no treatment.[22-24,26] A definitive conclusion on the therapeutic effects of thoracic manipulation cannot be made due to the heterogeneity and contradictory findings in the literature. The case report highlighted one example of a patient who responded to the use of thoracic manipulation combined with exercise as an intervention for neck pain. In this example, after physical therapy treatment, the patient experienced significant improvements in clinical outcomes measured. Future studies that control for acuity of neck pain, manipulation technique, and exercise combination may provide greater consensus on the subject.

Table 5. Precautions to Thoracic Manipulation[11]

Adverse reaction to previous TJM
Minor Osteoporosis
Disc herniation and disc protrusion
Spondylolisthesis
Hypermobility
Arterial Calcification
Arterial hypertension
Serious kyphosis or scoliosis
Vertigo
Systemic infection
Psychologic dependence on manipulation
No change or worsening symptoms

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