**JAMES R. DUNNING,** DPT, MSc Manip Ther, FAAOMPT[1] • **JOSHUA A. CLELAND,** PT, PhD[2] • **MARK A. WALDROP,** DPT, Cert SMT[3]
**CATHY ARNOT,** DPT, FAAOMPT[4] • **IAN YOUNG,** PT, DSc[5] • **MICHAEL TURNER,** PT, FAAOMPT[6] • **GISLI SIGURDSSON,** PT, MSc Manip Ther[7]

# Upper Cervical and Upper Thoracic Thrust Manipulation Versus Nonthrust Mobilization in Patients With Mechanical Neck Pain: A Multicenter Randomized Clinical Trial

**STUDY DESIGN:** Randomized clinical trial.

**OBJECTIVE:** To compare the short-term effects of upper cervical and upper thoracic high-velocity low-amplitude (HVLA) thrust manipulation to nonthrust mobilization in patients with neck pain.

**BACKGROUND:** Although upper cervical and upper thoracic HVLA thrust manipulation and nonthrust mobilization are common interventions for the management of neck pain, no studies have directly compared the effects of both upper cervical and upper thoracic HVLA thrust manipulation to nonthrust mobilization in patients with neck pain.

**METHODS:** Patients completed the Neck Disability Index, the numeric pain rating scale, the flexion-rotation test for measurement of C1-2 passive rotation range of motion, and the craniocervical flexion test for measurement of deep cervical flexor motor performance. Following the baseline evaluation, patients were randomized to receive either HVLA thrust manipulation or nonthrust mobilization to the upper cervical (C1-2) and upper thoracic (T1-2) spines. Patients were reexamined 48-hours after the initial examination and again completed the outcome measures. The effects of treatment on disability, pain, C1-2 passive rotation range of motion, and motor performance of the deep cervical flexors were examined with a 2-by-2 mixed-model analysis of variance (ANOVA).

**RESULTS:** One hundred seven patients satisfied the eligibility criteria, agreed to participate, and were randomized into the HVLA thrust manipulation (n = 56) and nonthrust mobilization (n = 51) groups. The 2-by-2 ANOVA demonstrated that patients with mechanical neck pain who received the combination of upper cervical and upper thoracic HVLA thrust manipulation experienced significantly ($P<.001$) greater reductions in disability (50.5%) and pain (58.5%) than those of the nonthrust mobilization group (12.8% and 12.6%, respectively) following treatment. In addition, the HVLA thrust manipulation group had significantly ($P<.001$) greater improvement in both passive C1-2 rotation range of motion and motor performance of the deep cervical flexor muscles as compared to the group that received nonthrust mobilization. The number needed to treat to avoid an unsuccessful outcome was 1.8 and 2.3 at 48-hour follow-up, using the global rating of change and Neck Disability Index cut scores, respectively.

**CONCLUSION:** The combination of upper cervical and upper thoracic HVLA thrust manipulation is appreciably more effective in the short term than nonthrust mobilization in patients with mechanical neck pain.

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Approximately 54% of individuals have experienced neck pain within the last 6 months,[24] and the incidence of neck pain may be increasing.[76] The economic burden associated with the management of patients with neck pain is high, second only to low back pain in annual workers' compensation costs in the United States.[98]

Two recent clinical prediction rules[17,21,22,81] have been developed in an attempt to guide treatment selection for patients with neck pain. However, one has yet to be validated and only identifies those patients with neck pain likely to benefit from cervical traction,[81] and the other, which attempted to identify those patients with neck pain likely to benefit from thoracic manipulation and a general cervical range-of-motion (ROM) exer-

[1]Manipulative Physiotherapist, Alabama Physical Therapy & Acupuncture, Montgomery, AL; PhD student, Nova Southeastern University, Fort Lauderdale, FL. [2]Professor, Franklin Pierce University, Concord, NH. [3]Owner, Newberry Physical Therapy & Sports Medicine, Newberry, SC. [4]Assistant Professor, University of South Carolina, Columbia, SC. [5]Senior Physical Therapist, Sport & Spine Physical Therapy, Savannah, GA. [6]Owner, OrthoSport Physical Therapy, Honolulu, HI. [7]Manipulative Physiotherapist, The Physiotherapy Clinic of Orkuveitan, Reykjavick, Iceland. This study was funded by the 2009 American Academy of Orthopaedic Manual Physical Therapists OPTP Grant. The study was approved by the Institutional Review Boards at the University of South Carolina, the Northeast Hospital Corporation, and the Corporate Clinical Research Committee. Address correspondence to Dr James Dunning, 1036 Old Breckenridge Lane, Montgomery, AL 36117. E-mail: jamesdunning@hotmail.com

cise, was shown not to be valid in a follow-up clinical trial.[17,22] Neither of these clinical prediction rules[17,21,22,81] guides the selection of high-velocity low-amplitude (HVLA) thrust manipulation or nonthrust mobilization to the cervical spine in patients with mechanical neck pain.

Recently, considerable evidence has been identified favoring the effectiveness of thoracic HVLA thrust manipulation over thoracic nonthrust mobilization, infrared radiation therapy, transcutaneous electrical nerve stimulation, soft tissue massage, or placebo manipulation in patients with acute and subacute neck pain in both the short and long term[17,18,21,22,25,36,37]; however, several studies have also found results to the contrary.[59,84] Only 2 studies[60,85] have examined the effect of thoracic HVLA thrust manipulation in patients with chronic neck pain. Immediately following a single HVLA thrust manipulation directed to T3-4, Sillevis et al[85] found no significant between-group difference in pain when compared to a placebo intervention.[85] In contrast, at 6-month follow-up, Lau et al[60] found that patients experienced significantly greater reductions in disability when 8 sessions of thoracic HVLA thrust manipulation were included as part of a multimodal intervention[60]; however, between-group differences in pain were not statistically significant. Moreover, the most recent systematic review[38] found low-quality evidence favoring a single session of thoracic HVLA thrust manipulation when compared to placebo for pain relief in patients with chronic neck pain.

There is evidence to suggest that a single session of cervical HVLA thrust manipulation is efficacious in the short term for pain reduction.[15,38,68] However, in contrast, Hurwitz et al[46] compared the effectiveness of cervical HVLA thrust manipulation with cervical nonthrust mobilization in patients with subacute and chronic neck pain, with or without radiculopathy, and reported no significant difference in pain and disability between the groups at 6 months.[46] However, in the Hurwitz et al[46] study, an unknown number of patients did not actually receive manipulation or mobilization to the cervical spine but, instead, received only manipulation or mobilization to the thoracic spine. Likewise, Leaver et al[61] found that patients with acute neck pain treated with cervical HVLA thrust manipulation did not experience a more rapid recovery than those treated with cervical nonthrust mobilization; however, an undisclosed number of subjects in both treatment groups also received manipulation or mobilization to the thoracic and lumbar spines. Nevertheless, the most recent systematic review[38] found moderate- to low-quality evidence that cervical HVLA thrust manipulation produced no difference in pain, disability, or patient satisfaction, when compared to cervical nonthrust mobilization for subacute or chronic neck pain at short-term follow-up.

Parkin-Smith and Penter[78] compared cervical HVLA thrust manipulation with the combined treatment of cervical and thoracic HVLA thrust manipulation in patients with mechanical neck pain of undefined duration and found no significant difference in pain and disability between the groups after 6 treatment sessions.[78] In contrast, and more recently, in patients with acute neck pain, Puentedura et al[80] found significantly greater improvements in pain and disability at short- and long-term follow-up when HVLA thrust manipulation was directed to the cervical spine rather than the thoracic spine; however, the mean duration of symptoms for the patients in that trial[80] was just 15 days and the sample size was small (n = 24).

To date, there is conflicting evidence as to whether cervical HVLA thrust manipulation or nonthrust mobilization has any mechanical effect on ROM[15,23,68,93,97] or neurophysiological effect on motor performance of the paravertebral or extremity muscles.[7,28,45,55,69,88,90] Nevertheless, the C1-2 articulation has been found to have a high frequency of symptomatic involvement in patients with neck pain and headaches.[41,42,54,100] Previous studies have demonstrated that 39° to 45° of the total cervical ROM occurs at the C1-2 articulation,[1,27,41,71,77] and that only 4° to 8° of rotation occurs at each motion segment from C2-3 to C6-7.[71] Furthermore, following upper cervical HVLA thrust manipulation, immediate and significant improvements in C1-2 rotation asymmetry have been demonstrated.[23]

The rationale to include HVLA thrust manipulation and/or nonthrust mobilization to the thoracic spine in the treatment of patients with neck pain comes from the theory that disturbances in joint mobility in the upper thoracic spine may be an underlying contributor to musculoskeletal disorders in the cervical spine.[17,22,44,50,58,60] Furthermore, several studies[17,21,22,60,73-75] have reported a significant association between decreased mobility in the cervicothoracic junction (C7-T2) and the presence of mechanical neck pain. HVLA thrust manipulation and/or nonthrust mobilization targeted to the atlantoaxial joint (C1-2) and the upper thoracic region (T1-2) are very frequently delivered by chiropractors, osteopaths, and physical therapists[11,35,41,44,54] in patients with mechanical neck pain; however, to date, no studies have investigated whether HVLA thrust manipulation to both the upper cervical and upper thoracic spines will result in enhanced outcomes over nonthrust mobilization to the same regions in patients with mechanical neck pain.

Therefore, the purpose of this study was to compare the short-term mechanical and neurophysiological effects of 2 different manual physical therapy techniques directed to the upper cervical and upper thoracic spines in patients with mechanical neck pain. We hypothesized that patients receiving a single session of HVLA thrust manipulation targeted to the upper cervical (C1-2) and upper thoracic (T1-2) articulations would experience greater increases in ROM, greater reductions in pain and disability, and greater improvements in motor performance of the deep cervical flexors 48 hours following intervention than patients receiving nonthrust mobilization to the same articulations.

## METHODS

### Participants

In this multicenter clinical trial, we recruited consecutive patients with mechanical neck pain who presented to 1 of 7 outpatient physical therapy clinics in a variety of geographical locations (Arizona, Hawaii, Massachusetts, South Carolina, Texas, and Virginia), over a 20-month period (from August 2009 to March 2011). To be eligible for inclusion, patients had to present with a primary complaint of neck pain (defined as pain in the region between the superior nuchal line and first thoracic spinous process) of any duration, to be between 18 and 70 years of age, and to have a Neck Disability Index (NDI) score of 20% or greater (10 points or greater on a 0-to-50 scale). Patients were excluded if they exhibited any red flags (tumor, fracture, metabolic diseases, rheumatoid arthritis, osteoporosis, resting blood pressure greater than 140/90 mmHg, prolonged history of steroid use, etc), presented with 2 or more positive neurologic signs consistent with nerve root compression (muscle weakness involving a major muscle group of the upper extremity, diminished upper extremity deep tendon reflex, or diminished or absent sensation to pinprick in any upper extremity dermatome), presented with a diagnosis of cervical spinal stenosis, exhibited bilateral upper extremity symptoms, had evidence of central nervous system involvement (hyperreflexia, sensory disturbances in the hand, intrinsic muscle wasting of the hands, unsteadiness during walking, nystagmus, loss of visual acuity, impaired sensation of the face, altered taste, the presence of pathological reflexes), had a history of whiplash injury within the previous 6 weeks, had prior surgery to the neck or thoracic spine, had received treatment for neck pain from any practitioner within the previous month, or had pending legal action regarding their neck pain.

The most recent literature suggests that premanipulative cervical artery testing may be unable to identify individuals at risk of vascular complications from cervical HVLA thrust manipulation[57,92] and that any symptoms detected during premanipulative testing may be unrelated to changes in blood flow in the vertebral artery, so that a negative test may neither predict the absence of arterial pathology nor the propensity of the artery to be injured during cervical HVLA thrust manipulation, with testing being neither sensitive or specific.[56,57,63,65,92] Screening questions for cervical artery disease were negative, and premanipulative cervical artery testing was not used. This study was approved by the Institutional Review Boards of the University of South Carolina, Northeast Hospital Corporation, and the Corporate Clinical Research Committee. All patients provided informed consent before their enrollment in the study.

### Treating Therapists

Seven physical therapists (mean ± SD age, 37.4 ± 6.19 years) participated in the delivery of treatment for all patients in this study. These treating therapists had an average of 12.5 ± 4.93 (range, 6.0-18.0) years of clinical experience, and all had completed a 60-hour postgraduate certification program that included practical training in the use of upper cervical and upper thoracic HVLA thrust manipulation. To ensure that all examination, outcome assessments, and treatment procedures were standardized, all participating physical therapists were required to study a manual of standard operating procedures, to watch a 45-minute instructional DVD, and to participate in a 4-hour training session with the principal investigator.

### Examination Procedures

All patients provided demographic information and completed a number of self-report measures, followed by a standardized history and physical examination at baseline. Self-report measures included the NDI and the numeric pain rating scale (NPRS). The standardized physical examination included, but was not limited to, measurements of C1-2 (atlantoaxial joint) passive right and left rotation ROM using the flexion-rotation test (FRT) and motor performance of the deep cervical flexors using the craniocervical flexion test (CCFT). In each of the 7 clinics, a physical therapist blind to group assignment performed all examination and outcome assessment procedures.

### Outcome Measures

The primary outcome measure used in this study was the patient's perceived level of disability as measured by the NDI. The NDI is the most widely used condition-specific disability scale for patients with neck pain and consists of 10 items addressing different aspects of function, each scored from 0 to 5, with a maximum score of 50 points.[64,94] Higher scores represent increased levels of disability. The NDI has been demonstrated to be a reliable and valid outcome measure for patients with neck pain.[64]

We chose to only include patients with an NDI score of 10 points (20%) or greater, because this cut-off score captures the minimal clinically important difference (MCID) for the NDI, which has been reported to range from 7 points[64] (14%) to 9 points[99] (18%) on the 0-to-50 scale.

Secondary outcome measures included the NPRS, the FRT, the CCFT and the global rating of change (GRC). The NPRS was used to capture the patient's level of pain. Patients were asked to indicate the intensity of their current pain level using an 11-point scale, ranging from 0 (no pain) to 10 (worst pain imaginable).[49] The minimal detectable change has been reported to be 2.1, whereas the MCID was shown to be 1.3, in patients with mechanical neck pain.[19]

Patients also underwent measurements of C1-2 (atlantoaxial joint) passive right and left rotation ROM using the FRT. A cervical range of motion (CROM) device (Performance Attainment Associates, Roseville, MN) was placed on the patient's head. Then, with the patient in supine, the patient's neck was fully flexed then rotated to the right and left. The

ROM was considered limited when the examiner determined a firm resistance or provoked pain; the amount of unilateral C1-2 passive rotation to the right and left was then documented. For experienced examiners, the ICC values for the FRT have recently been found to be 0.93 (95% CI: 0.87, 0.96),[43] indicating excellent interexaminer reliability. Furthermore, the FRT has been found to possess high diagnostic validity for determining the presence of C1-2 joint dysfunction, with Ogince et al[77] reporting sensitivity and specificity of 91% and 90%, respectively, and Hall et al[43] reporting sensitivity and specificity of 90% and 88%, respectively. For asymptomatic subjects, mean unilateral ROM during the FRT, to the left or right, has been found to be 39° to 45°[1,42,43,77]; whereas subjects with C1-2 joint dysfunction have been found to possess only 22° to 26°[42,43,77] of unilateral ROM towards the most restricted side during the FRT.

In addition, the motor performance of the deep cervical flexors was tested on all patients using the CCFT. Although the CCFT is an indirect measure of deep cervical flexor muscle activation and strength, the validity[29,30] and reliability[16,32,51,52] of the CCFT have been established. Patients with type 2 whiplash-associated disorder or idiopathic neck pain have been found to be able to control 23 to 24 mmHg before pain or substitution occurs,[16,51] whereas asymptomatic individuals have been found to be able to control 28 to 30 mmHg for a 10-second hold.[16,29,31] The CCFT was performed with the patient in supine, with the knees bent and the position of the head standardized by placing the craniocervical and cervical spines in a mid position, such that a line between the subject's forehead and chin was horizontal, and a horizontal line from the tragus of the ear bisected the neck longitudinally. If necessary, layers of towel were placed under the head to obtain this starting position. An air-filled pressure biofeedback unit (Chattanooga Group, Inc, Hixson, TN) was placed suboccipitally behind the patient's neck and preinflated to a baseline of 20 mmHg.[51] For the staged test, patients were required to perform the craniocervical flexion action ("a nod of the head, similar to indicating yes")[51] and attempt to visually target pressures of 22, 24, 26, 28, and 30 mmHg from a resting baseline of 20 mmHg, and to hold the position steady for 10 seconds.[29,30] The action of nodding was performed in a gentle and slow manner. A 10-second rest was allowed between trials.[51] If the pressure deviated below the target pressure, the pressure was not held steadily, substitution with the superficial flexors (sternocleidomastoid or anterior scalene) occurred, or neck retraction was noticed before the completion of the 10-second isometric hold, it was regarded as a failure[51] and the last successful target pressure was used for data analysis. Patients were allowed to practice the action of craniocervical flexion at the 5 progressive incremental targets, and, at that time, the researcher identified and discouraged the use of substitution strategies.

Patients completed all outcome measures then received the intervention. Patients then returned for a 48-hour follow-up, at which the aforementioned outcome measures were collected. In addition, at the 48-hour follow-up, patients completed a 15-point GRC scale, a scale described by Jaeschke et al,[48] to rate their own perception of improved function. The scale ranges from –7 (a very great deal worse) to 0 (about the same) to +7 (a very great deal better). Intermittent descriptors of worsening or improving are assigned values from –1 to –6 and +1 to +6, respectively. All outcome measures were collected by an assessor, who was blinded to group assignment.

## Randomization

Following the baseline examination, patients were randomly assigned to receive either the HVLA thrust manipulation or nonthrust mobilization procedures. Concealed allocation was performed by using a computer-generated randomized table of numbers, created by an individual not involved with recruiting patients, prior to the beginning of the study. Individual, sequentially numbered index cards with the random assignment were prepared for each of 7 data collection sites. The index cards were folded and placed in sealed opaque envelopes. Blinded to the baseline examination, the treating therapist opened the envelope and proceeded with treatment according to the group assignment. Patients were instructed not to discuss the particular treatment procedure received with the examining therapist. The examining therapist remained blind to the patient's treatment group assignment at all times; however, based on the nature of the interventions, it was not possible to blind patients or treating therapists.

## Treatment Procedures

Patients in both groups were treated for 1 session and then returned 48 hours later to complete outcome measurements. The treatment program consisted of 2 components: (1) either upper cervical and upper thoracic HVLA thrust manipulation or upper cervical and upper thoracic nonthrust mobilization, and (2) advice to maintain usual activity within the limits of pain.

## HVLA Thrust Manipulation Group

A single HVLA thrust manipulation directed to the upper cervical spine (C1-2) with the patient supine was performed. For this technique, the patient's left posterior arch of the atlas was contacted with the lateral aspect of the proximal phalanx of the therapist's left second finger using a "cradle hold." To localize the forces to the left C1-2 articulation, secondary levers of extension, posterior-anterior (PA) shift, ipsilateral side-bend, and contralateral side-shift were used. While maintaining the secondary levers, the therapist performed a single HVLA thrust manipulation to the left atlanto-axial joint, using the combined thrusting primary levers of right rotation in an arc toward the underside eye and translation toward the table (**FIGURE 1**). This was repeated using the

**FIGURE 1.** High-velocity low-amplitude thrust manipulation directed to the right C1-2 articulation.

same procedure but directed to the right C1-2 articulation.

A single HVLA thrust manipulation directed bilaterally to the upper thoracic (T1-2) spine, with the patient supine, was performed. For this technique the patient held her/his arms and forearms across the chest, with the elbows aligned in a superoinferior direction. The therapist contacted the transverse processes of the lower vertebrae of the target motion segment with the thenar eminence and middle phalanx of the third digit. The upper lever was localized to the target motion segment by adding the secondary levers of rotation away and sidebending towards the therapist; and the lower lever, or underside hand, used pronation and radial deviation to achieve rotation-toward and sidebending-away moments, respectively. The space inferior to the xiphoid process and costochondral margin of the therapist was used as the contact point against the patient's elbows to deliver a HVLA thrust manipulation in an anterior-to-posterior direction, targeting T1-2 bilaterally (**FIGURE 2**).

For both the upper cervical and upper thoracic HVLA thrust manipulations, if no popping or cracking sound was heard on the first attempt, the therapist repositioned the patient by adjusting the secondary levers and performed a second HVLA thrust manipulation. A maximum of 2 attempts were performed on each

**FIGURE 2.** High-velocity low-amplitude thrust manipulation directed bilaterally to the upper thoracic (T1-2) spine.

patient.[21,36,37,60]

### Nonthrust Mobilization Group

Nonthrust mobilization directed to the upper cervical (C1-2) spine, with the patient prone, was performed. For this technique, the therapist performed one 30-second bout of left-sided unilateral grade IV PA mobilizations to the C1-2 motion segment, as described by Maitland.[66] This same procedure was repeated for one 30-second bout to the right atlantoaxial joint.

Nonthrust mobilization directed to the upper thoracic (T1-2) spine, with the patient prone, was performed. For this technique, the therapist performed one 30-second bout of central grade IV PA mobilizations to the T1-2 motion segment, as described by Maitland.[66]

The required times to complete the HVLA thrust manipulations and the nonthrust mobilization procedures were similar, to minimize the potential for an "attention effect." There is no high-quality evidence to date to suggest that longer durations of nonthrust mobilization result in greater pain reduction than shorter durations or dosages of nonthrust mobilization.[38,72] Moreover, Moss et al[72] found that 9 minutes (3 sets of 3 minutes) of grade III tibiofemoral anterior-posterior nonthrust mobilizations had the same effect on clinical measures of pain (visual analog scale during the timed up-and-go functional test and the Western Ontario and McMaster Universities Osteoarthritis Index pain subscale) as did 9 minutes of manual contact. Therefore, a "contact effect" or attention effect would likely occur if the total contact time of the nonthrust mobilization procedures exceeded the total contact time of the HVLA thrust manipulation procedures in this study. This, in brief, is why we limited the dosage of the nonthrust mobilizations to one 30-second set for each side and region.

### Risks of Cervical HVLA Thrust Manipulation and Nonthrust Mobilization

Considerable attention has been given to the potential risks associated with HVLA thrust manipulation procedures in the cervical region.[12,14,40,56,57] Although beyond the scope of the current article, the most recent and robust evidence for the risk of vertebrobasilar stroke and cervical HVLA thrust manipulation comes from the case control study by Cassidy et al.[14] Contrary to traditionally held views,[83,87] Cassidy et al[14] found no evidence of excess risk of vertebrobasilar stroke associated with cervical HVLA thrust manipulation as compared to primary medical physician care. Moreover, a recent systematic review[12] concluded that there has been no strong evidence linking the occurrence of serious adverse events with the use of cervical manipulation or mobilization in adults with neck pain.

The 2 largest randomized controlled trials[46,61] within the past 10 years that have directly compared the effectiveness of cervical HVLA thrust manipulation with cervical nonthrust mobilization did not report the specific vertebral motion segment targeted with the cervical HVLA thrust manipulation procedure. That is, it is not known whether patients with acute or chronic neck pain received upper, middle, or lower cervical HVLA thrust manipulation in these 2 trials.[46,61] Furthermore, there were no serious neurovascular adverse events reported by any participants in either of the trials,[46,61] and both trials reported no statistically significant difference in the incidence of minor adverse events between the cervical HVLA thrust manipulation and cervical

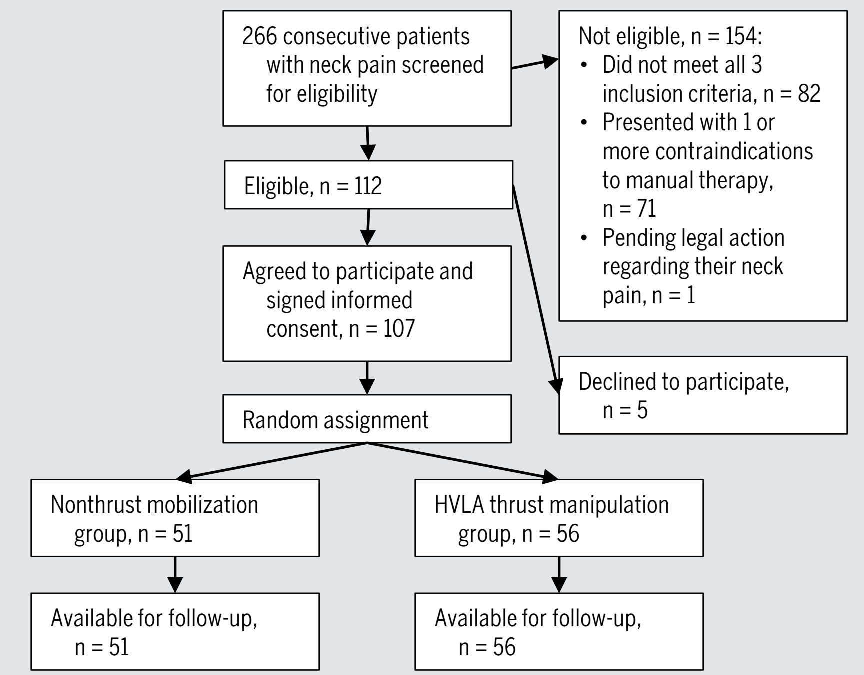


**FIGURE 3.** Flow diagram of patient recruitment and retention.

nonthrust mobilization groups. Therefore, to date, there is no strong empirical evidence to support the notion that upper cervical HVLA thrust manipulation carries any greater risk of injury than middle or lower cervical HVLA thrust manipulation, or that nonthrust mobilization to any region of the cervical spine carries any less risk than HVLA thrust manipulation to the same region.[12,14,40,57]

### Sample Size

The sample size and power calculations were performed using online software from the MGH Biostatistics Center (Boston, MA). The calculations were based on a 5-point (or 10%) difference in the NDI at the 48-hour follow-up, assuming a standard deviation of 7 points, a 2-tailed test, and an alpha level equal to .05. This generated a sample size of 43 patients per group. Allowing for a conservative dropout rate of 20%, we planned to recruit at least 104 patients into the study. This sample size yielded greater than 90% power to detect a statistically significant change in the NDI scores.

### Data Analysis

Descriptive statistics, including frequency counts for categorical variables and measures of central tendency and dispersion for continuous variables, were calculated to summarize the data. Baseline demographic data were compared between treatment groups using independent *t* tests for continuous data, and chi-square tests of independence for categorical data to assess the adequacy of the randomization. The primary aim (effects of treatment on disability, pain, C1-2 passive rotation ROM, and motor performance of the deep cervical flexors) was examined with a 2-by-2 mixed-model analysis of variance (ANOVA), with treatment group (HVLA thrust manipulation versus nonthrust mobilization) as the between-subject variable and time (baseline, 48-hour follow-up) as the within-subject variable. Separate ANOVAs were performed with the NDI, NPRS, FRT right, FRT left, and CCFT as the dependent variable. For each ANOVA, the hypothesis of interest was the 2-way interaction (group by time). Planned pairwise comparisons were performed, examining the difference between baseline and follow-up periods using the Bonferroni correction at an alpha level of .05.

Additionally, we dichotomized patients as having experienced a successful outcome using a cut score of 50% improvement[53] on the NDI or greater than or equal to +4 on the GRC.[21] It has been reported that scores of +4 are indicative of moderate changes in patient status and have been previously used as a measure of success in clinical research.[17,96] We then calculated the numbers needed to treat (NNT) and 95% confidence intervals (CIs) at the 48-hour follow-up using both of these definitions for a successful outcome. Data analysis was performed using SPSS 19.0.

## RESULTS

Two hundred sixty-six patients with a primary complaint of neck pain were screened for possible eligibility. The reasons for ineligibility can be found in **FIGURE 3**, the flow diagram of patient recruitment and retention. Of the 266 patients screened, 107 patients (mean ± SD age, 42.0 ± 12.8 years; duration of symptoms, 352 ± 476 days) satisfied the eligibility criteria, agreed to participate, and were randomized into the HVLA thrust manipulation (n = 56) and nonthrust mobilization (n = 51) groups. Seven therapists from 7 outpatient physical therapy clinics each treated 27, 23, 23, 12, 11, 6, and 5 patients, respectively. Furthermore, each of the 7 therapists treated approximately an equal proportion of patients in each group. There was no significant difference between the groups in any of the baseline characteristics (**TABLE 1**). All 107 patients completed the 48-hour follow-up and were included in the intention-to-treat data analysis.

The within-group change scores and between-group differences with 95% CIs for all outcome measures can be found in

**TABLE 2**. In addition, the preintervention and postintervention scores, with means and standard deviations for pain, disability, C1-2 passive rotation ROM, and motor performance of the deep cervical flexor muscles, can be found in **TABLE 3**.

## Neck Disability

A 2-by-2 mixed-model ANOVA revealed a significant interaction of group (HVLA thrust manipulation versus nonthrust mobilization) by time (baseline to 48 hours posttreatment) for the NDI ($F_{1,105}$ = 52.88; *P*<.001; partial eta-squared, 0.34). Group means for the NDI at each time period demonstrated that the HVLA thrust manipulation group experienced lower disability levels (10.8 points [95% CI: 8.9, 12.9]) than the nonthrust mobilization group (18.4 [95% CI: 16.4, 20.5]) at 48 hours following treatment. An independent-samples *t* test revealed that the between-group mean change in disability (8.0 points [95% CI: 5.9, 10.2]) from baseline to 48-hour follow-up was statistically significant ($t_{105}$ = 7.27, *P*<.001); that is, the HVLA thrust manipulation group experienced significantly greater disability reduction (10.89 ± 6.43 points) than the nonthrust mobilization group (2.84 ± 4.81 points) following treatment.

In addition, an independent-samples *t* test revealed that the between-group difference in mean percentage change in disability (37.7% points [95% CI: 28.5, 46.9]) from baseline to 48-hour follow-up was statistically significant ($t_{105}$ = 8.153; *P*<.001); that is, the HVLA thrust manipulation group experienced a significantly greater percentage in disability reduction (50.5% ± 22.7%) than the nonthrust mobilization group (12.8% ± 25.2%) following treatment (**FIGURE 4**). Additionally, significantly (*P*<.001) more patients in the HVLA thrust manipulation group (n = 29, 51.8%) achieved a successful outcome (greater than or equal to 50% improvement in disability, as measured by the NDI at 48-hour follow-up) compared to the nonthrust mobilization group (n = 4, 7.8%). Based on these values, the NNT was 2.3 (95% CI: 1.7, 3.5); that is, on average, 2 patients with neck pain would need to be treated with upper cervical and upper thoracic HVLA thrust manipulation to avoid an unsuccessful outcome in 1 of the 2 patients at 48-hour follow-up.

**TABLE 1** Baseline Variables: Demographics, Outcome Measures, Physical Impairments*

| Baseline Variable | HVLA Thrust Manipulation Group (n = 56) | Nonthrust Mobilization Group (n = 51) | *P* Value |
|---|---|---|---|
| Age, y | 41.5 ± 11.9 | 42.7 ± 13.9 | .64† |
| Gender, n (%) female | 38 (68%) | 35 (69%) | .93‡ |
| Duration of symptoms, d | 336.9 ± 527.7 | 367.9 ± 418.6 | .74† |
| NPRS§ | 5.3 ± 1.7 | 5.3 ± 2.0 | .86† |
| NDI‖ | 21.7 ± 8.2 | 21.3 ± 8.8 | .78† |
| BMI, kg/m² | 25.3 ± 4.8 | 25.6 ± 6.2 | .80† |
| FRT right, deg¶ | 28.0 ± 7.7 | 29.7 ± 6.9 | .24† |
| FRT left, deg¶ | 31.0 ± 7.3 | 29.7 ± 6.8 | .34† |
| CCFT, mmHg# | 24.1 ± 2.1 | 23.7 ± 2.0 | .30† |

*Abbreviations: BMI, body mass index; CCFT, craniocervical flexion test; FRT, flexion-rotation test; HVLA, high-velocity low-amplitude; NDI, Neck Disability Index; NPRS, numeric pain rating scale.*
**Data are mean ± SD, except for gender.*
*†Independent samples t test.*
*‡Chi-square test.*
*§0 to 10, with lower scores indicating less pain.*
*‖0 to 50, with lower scores indicating greater function.*
*¶Higher scores indicate greater passive C1-2 rotation range of motion.*
*#20 to 30 mmHg, with higher scores indicating greater motor performance of the deep cervical flexors.*

**TABLE 2** Within-Group Change Scores and Pairwise Comparisons of Between-Group Change Scores Using Independent-Samples *t* Tests*

| Variable | Within-Group Change Scores for HVLA Thrust Manipulation | Within-Group Change Scores for Nonthrust Mobilization | Between-Group Difference in Change Scores |
|---|---|---|---|
| NPRS† | 2.9 (2.6, 3.3) | 1.0 (0.5, 1.4) | 2.0 (1.5, 2.5), *P*<.001 |
| NDI‡ | 10.9 (9.2, 12.6) | 2.8 (1.5, 4.2) | 8.0 (5.9, 10.2), *P*<.001 |
| FRT right, deg§ | 8.4 (6.8, 10.0) | 3.5 (1.8, 5.1) | 4.9 (2.7, 7.2), *P*<.001 |
| FRT left, deg§ | 5.9 (4.2, 7.6) | 2.5 (1.0, 4.0) | 3.4 (1.1, 5.6), *P* = .004 |
| CCFT, mmHg‖ | 3.4 (2.8, 4.1) | 1.2 (0.6, 1.8) | 2.2 (1.3, 3.1), *P*<.001 |

*Abbreviations: CCFT, craniocervical flexion test; FRT, flexion-rotation test; HVLA, high-velocity low-amplitude; NDI, Neck Disability Index; NPRS, numeric pain rating scale.*
**Values represent mean difference from baseline to 48-hour follow-up (95% confidence interval).*
*†0 to 10, with lower scores indicating less pain.*
*‡0 to 50, with lower scores indicating greater function.*
*§Higher scores indicate greater passive C1-2 rotation range of motion.*
*‖20 to 30 mmHg, with higher scores indicating greater motor performance of the deep cervical flexors.*

## Neck Pain

A mixed-model 2-by-2 ANOVA revealed a significant interaction of group (HVLA thrust manipulation versus nonthrust mobilization) by time (baseline to 48 hours posttreatment) for the NPRS ($F_{1,105}$ = 57.33, *P*<.001; partial eta-squared, 0.35). Group means for the NPRS at each time period demonstrated that the HVLA thrust manipulation group experienced lower pain levels (2.3 [95% CI: 1.9, 2.7]) than the nonthrust mobilization group (4.4 [95% CI: 3.9, 4.8]) 48 hours following treatment. An independent samples *t* test revealed that the between-

TABLE 3 Preintervention and Postintervention Scores for Pain, Disability, Passive C1-2 Rotation Range of Motion, and Motor Performance of the Deep Cervical Flexor Muscles*

| Variable | Preintervention: HVLA Thrust Manipulation Group (n = 56) | Preintervention: Nonthrust Mobilization Group (n = 51) | Postintervention: HVLA Thrust Manipulation Group (n = 56) | Postintervention: Nonthrust Mobilization Group (n = 51) |
|---|---|---|---|---|
| NPRS† | 5.3 ± 1.7 | 5.3 ± 2.0 | 2.3 ± 1.5 | 4.4 ± 1.7 |
| NDI‡ | 21.7 ± 8.2 | 21.3 ± 8.8 | 10.8 ± 6.0 | 18.4 ± 8.6 |
| FRT right, deg§ | 28.0 ± 7.7 | 29.7 ± 6.9 | 36.4 ± 6.4 | 33.1 ± 9.7 |
| FRT left, deg§ | 31.0 ± 7.3 | 29.7 ± 6.8 | 36.9 ± 6.1 | 32.2 ± 7.2 |
| CCFT, mmHg‖ | 24.1 ± 2.1 | 23.7 ± 2.0 | 27.5 ± 2.1 | 24.9 ± 2.6 |

*Abbreviations: CCFT, craniocervical flexion test; FRT, flexion-rotation test; HVLA, high-velocity low-amplitude; NDI, Neck Disability Index; NPRS, numeric pain rating scale.*
**Data are mean ± SD.*
*†0 to 10, with lower scores indicating less pain.*
*‡0 to 50, with lower scores indicating greater function.*
*§Higher scores indicate greater passive C1-2 rotation range of motion.*
*‖20 to 30 mmHg, with higher scores indicating greater motor performance of the deep cervical flexors.*

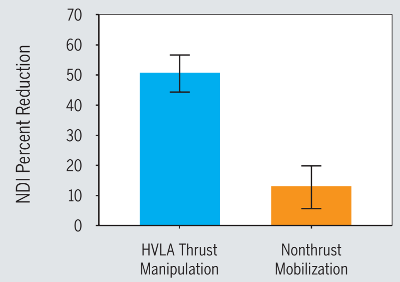


**FIGURE 4.** Mean and 95% confidence interval for percentage of reduction in the Neck Disability Index (NDI) score from baseline to follow-up for the high-velocity low-amplitude (HVLA) thrust manipulation and nonthrust mobilization groups (*P*<.001).

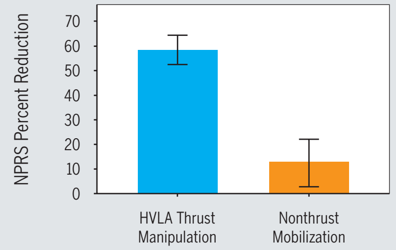


**FIGURE 5.** Mean and 95% confidence interval for percentage of reduction in the numeric pain rating scale (NPRS) score from baseline to follow-up for the high-velocity low-amplitude (HVLA) thrust manipulation and nonthrust mobilization groups (*P*<.001).

group mean reduction in pain (2.0 [95% CI: 1.5, 2.5]) from baseline to 48-hour follow-up was statistically significant ($t_{105}$ = 7.57, *P*<.001); that is, the HVLA thrust manipulation group experienced significantly greater pain reduction (mean ± SD, 2.95 ± 1.23 points) than the nonthrust mobilization group (0.96 ± 1.48 points) following treatment.

In addition, an independent-samples *t* test revealed that the between-group mean percentage change in pain (45.8% points [95% CI: 34.8, 56.8]) from baseline to 48-hour follow-up was statistically significant ($t_{105}$ = 8.272, *P*<.001); that is, the HVLA thrust manipulation group experienced a significantly greater percentage in pain reduction (mean ± SD, 58.5% ± 22.4%) than the nonthrust mobilization group (12.6% ± 34.2%) following treatment (**FIGURE 5**).

## Passive C1-2 Rotation Range of Motion

A significant group-by-time interaction was observed for passive C1-2 rotation ROM, as measured by the FRT right ($F_{1,105}$ = 18.45, *P*<.001; partial eta-squared, 0.15) and FRT left ($F_{1,105}$ = 8.78; *P* = .004; partial eta-squared, 0.08). The HVLA thrust manipulation group experienced significantly ($t_{105}$ = 4.30, *P*<.001) greater increases in passive C1-2 right rotation ROM (8.4° [95% CI: 6.8, 10.0]), as compared to the nonthrust mobilization group (3.5° [95% CI: 1.8, 5.1]), with a mean between-group difference of 4.9° (95% CI: 2.7, 7.2) (**FIGURE 6**). Likewise, the HVLA thrust manipulation group experienced significantly ($t_{105}$ = 2.96, *P* = .004) greater increases in passive C1-2 left rotation ROM (5.9° [95% CI: 4.2, 7.6]) as compared to the nonthrust mobilization group (2.5° [95% CI: 0.95, 4.0]), with a mean between-group difference of 3.4° (95% CI: 1.1, 5.6) (**FIGURE 7**).

## Deep Cervical Flexor Motor Performance

A significant group-by-time interaction was observed for motor performance of the deep cervical flexors as measured by the CCFT ($F_{1,105}$ = 25.66; *P*<.001; partial eta-squared, 0.20). Patients receiving a single session of upper cervical and upper thoracic HVLA thrust manipulation experienced significantly ($t_{105}$ = 5.07, *P*<.001) greater improvements in motor performance of the deep cervical flexors (3.4 mmHg [95% CI: 2.8, 4.1]) as compared to the nonthrust mobilization group (1.2 mmHg [95% CI: 0.64, 1.8]), with a mean between-group difference of 2.2 mmHg (95% CI: 1.3, 3.1) (**FIGURE 8**).

## Global Rating of Change

At 48-hour follow-up, the HVLA thrust manipulation group had significantly ($t_{105}$ = 8.12, *P*<.001) greater improvements based on the GRC measure (mean ± SD, +4.1 ± 1.8) as compared to the nonthrust mobilization group (+0.82 ± 2.4). Based on the cutoff score of +4 or better on the GRC, significantly (Pearson chi-square, 47.40; *P*<.001) more patients in the HVLA thrust manipulation group (n = 37, 66.1%) achieved a successful outcome compared to the nonthrust mobilization group (n = 6, 11.8%). Based on these values, the NNT was 1.8 (95% CI: 1.4, 2.6); that is, on average, 2 patients with neck pain would need to be treated with upper cervical and upper thoracic HVLA thrust manipulation to avoid

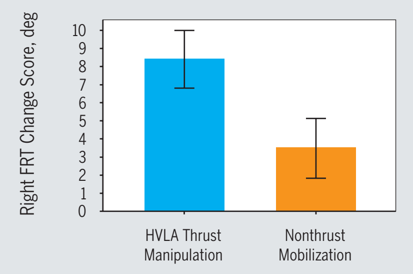


**FIGURE 6.** Within-group mean change score in C1-2 passive right rotation range of motion as measured by the flexion-rotation test (FRT) with 95% confidence interval from baseline to follow-up for the high-velocity low-amplitude (HVLA) thrust manipulation and nonthrust mobilization groups (*P*<.001).

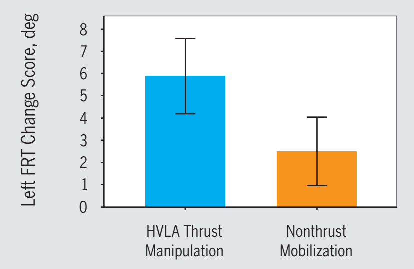


**FIGURE 7.** Within-group mean change score in C1-2 passive left rotation range of motion as measured by the flexion-rotation test (FRT) with 95% confidence interval from baseline to follow-up for the high-velocity low-amplitude (HVLA) thrust manipulation and nonthrust mobilization groups (*P* = .004).

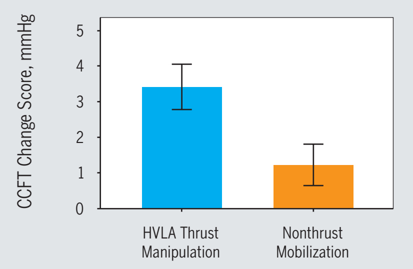


**FIGURE 8.** Within-group mean change score in motor performance of the deep cervical flexors as measured by the craniocervical flexion test (CCFT) with 95% confidence interval from baseline to follow-up for the high-velocity low-amplitude (HVLA) thrust manipulation and nonthrust mobilization groups (*P* <.001).

an unsuccessful outcome in 1 of the 2 patients at 48-hour follow-up.

We did not collect any data on the occurrence of "minor" adverse events[12,13] (transient neurological symptoms, increased stiffness, headache, radiating pain, fatigue, or other); however, no "major" adverse events[12,13] (death, stroke or permanent neurological deficits) were reported for either group.

## DISCUSSION

### Changes in Disability and Pain

To our knowledge, this study is the first randomized clinical trial to directly compare the effectiveness of both upper cervical and upper thoracic HVLA thrust manipulation to both upper cervical and upper thoracic nonthrust mobilization in patients with neck pain. The results of the current study suggest that a single session of HVLA thrust manipulation directed to both the upper cervical and upper thoracic spines results in greater improvements in disability, pain, atlantoaxial joint ROM, and motor performance of the deep cervical flexor muscles than nonthrust mobilization directed to the same regions. Furthermore, the point estimates for between-group changes in disability (8.0 points or 16.0%) and pain (2.0 points) exceeded the reported MCIDs for both measures. It should, however, be noted that the lower-bound estimate of the 95% CI for disability (5.9 points) was slightly below the MCID (7 points). In addition, using a cut point of 50% or greater improvement in disability on the NDI or a cut point of +4 or better on the GRC to define a successful outcome, the NNT was 2.3 and 1.8, respectively; that is, on average, 2 patients with mechanical neck pain would need to be treated with upper cervical and upper thoracic HVLA manipulation to avoid an unsuccessful outcome in 1 of the 2 patients at 48-hour follow-up. Furthermore, the upper-bound estimates of the 95% CI for the NNT were 3.5 (NDI) and 2.6 (GRC), and it has been suggested that physical therapy interventions with a NNT of less than 5 should be considered effective management strategies.[95] We also believe that the inclusion of 7 treating physical therapists from 7 private and hospital clinics in 6 different geographical states enhances the overall generalizability of the results.

Our results are contradictory to the findings of several other studies[10,46,61] that compared the effectiveness of cervical HVLA thrust manipulation with cervical nonthrust mobilization in patients with neck pain. However, in 1 of these studies[61] an undisclosed number of subjects in the cervical nonthrust mobilization group also received thoracic and/or lumbar HVLA thrust manipulation. In addition, randomization occurred after several conservative treatment sessions had already been completed or failed, and it is not known whether any subject actually received HVLA thrust manipulation to the upper cervical spine, as no description of the particular manipulation or mobilization techniques, dosages, or targeted vertebral levels is given by Leaver et al.[61] Likewise, an undisclosed proportion of patients in the study by Hurwitz et al[46] did not actually receive HVLAT manipulation or nonthrust mobilization to the cervical spine but, instead, received HVLAT manipulation or mobilization to the thoracic spine. Moreover, "two thirds" of the patients had concomitant headaches and "many" had neck pain of radiculopathic origin.[46] Therefore, the conclusions made by Hurwitz et al[46] and Leaver et al[61] should be viewed cautiously.

Our results are in agreement with several other studies[21,36,37,60] that compared the effectiveness of thoracic HVLA thrust manipulation with thoracic nonthrust mobilization, infrared radiation therapy, transcutaneous electrical nerve stimulation, soft tissue massage, or placebo manipulation in patients with neck pain. In patients with neck pain of less than 30 days in duration, Gonzalez-Iglesias et al[36,37] found between-group differences for pain of 1.7 to 2.7 points and 8.0 to 8.8 points for disability using the Northwick Park Neck Pain Questionnaire (NPQ) favoring the group that received thoracic HVLA manipulation. Similarly, in patients with chronic neck pain, Lau et al[60] reported between-group mean differences of 6.0 to 8.9 points for disability (NPQ) in favor of the thoracic HVLA thrust manipulation group; however, between-group differences in pain were not statistically significant. Our study found significant between-group mean differences of 8.0 points (16.0%) for disability (NDI) and 2.0 points for pain; likewise, Cleland et al[21] reported between-group mean differences of 5.0 points (10.0%) for disability (NDI) and 2.0 points for pain (NPRS) at 48-hour follow-up. Perhaps the combined effect of both upper cervical and upper thoracic HVLA thrust manipulation, as compared to thoracic HVLA thrust manipulation alone, explains the greater reduction in disability (NDI) found in our study than in that found by Cleland et al.[21] In addition, Puentedura et al[80] demonstrated greater reductions in disability at all follow-up points when the HVLA thrust manipulation was directed to the cervical spine rather than the thoracic spine in patients with neck pain; however, the sample size was just 24 patients and, unlike our study, the mean duration of symptoms in the Puentedura et al[80] study was just 15 days.

Biomechanical,[15,23,68,73-75,97] spinal or segmental,[3,4,6,8,28,88] and central descending inhibitory pain pathway[39,70,86,101] models have all been suggested as possible explanations for the immediate hypoalgesic effects observed following HVLA thrust manipulation. Recently, the biomechanical effects of HVLA thrust manipulation have been under scientific scrutiny,[6] and it is plausible that the clinical benefits found in our study are associated with a neurophysiological response involving temporal sensory summation at the dorsal horn of the spinal cord[3]; however, this proposed model is currently supported only by findings from transient, experimentally induced pain in healthy subjects[3-5,8,34] and not in patients with neck pain. In summary, there is currently insufficient evidence to support a dominant role of any of these 3 hypoalgesic mechanisms.

### Changes in C1-2 ROM

Spinal HVLA thrust manipulation and nonthrust mobilization techniques may not be specific to the target vertebral level[2,62,82]; nevertheless, we directed treatment to the atlantoaxial joints, because the C1-2 articulation has been found to have a high frequency of symptomatic involvement in patients with neck pain and headaches[41,42,54,100] and previous studies have demonstrated that this articulation is where the majority of cervical rotation occurs. Several studies have demonstrated that 39° to 45° of the total cervical rotation ROM occurs at the C1-2 articulation[1,27,41,71,77] and only 4° to 8° of rotation occurs at each motion segment from C2-3 to C6-7.[71] In the current study, the HVLA thrust manipulation group experienced mean increases in right rotation (8.4° [95% CI: 6.8, 10.0]) and left rotation (5.9° [95% CI: 4.2, 7.6]) ROM of the atlantoaxial joint. Furthermore, these differences were found to be significantly greater in the HVLA thrust manipulation group than in the nonthrust mobilization group. Similarly, Clements et al[23] demonstrated an immediate 7.5° improvement in C1-2 unilateral rotation ROM following HVLA thrust manipulation to the atlantoaxial joints. Further, this value falls between the upper- and lower-bound estimates of the 95% CI for C1-2 ROM changes found in our study.

### Changes in Deep Cervical Flexor Motor Performance

In the current study, the mean score on the CCFT improved from 24.1 mmHg (95% CI: 23.6, 24.7) to 27.5 mmHg (95% CI: 26.9, 28.1) following upper cervical and upper thoracic HVLA thrust manipulation; whereas, the mean score only improved from 23.7 mmHg (95% CI: 23.1, 24.3) to 24.9 mmHg (95% CI: 24.3 to 25.6) following nonthrust mobilization to the same. Although statistically significant, we are not certain if the between-group difference may be considered clinically important. Nevertheless, both groups began with strength and endurance deficits in the deep cervical flexor muscles that were similar to those previously found in patients with neck pain (23 to 24 mmHg on the CCFT),[16,51,52] and only the HVLA thrust manipulation group regained the ability to generate and control pressure, without substitution or pain, during the CCFT that very nearly approximated the normative value for asymptomatic individuals (28 mmHg on the CCFT).[16,51,52] Two previous studies[55,69] have demonstrated immediate increases in isometric strength of paravertebral muscles following HVLA thrust manipulation to the zygapophyseal joints, and 1 study[88] found immediate increases in elbow flexor muscle strength following cervical HVLA thrust manipulation. However, to our knowledge, the current study is the first to demonstrate significant increases in motor performance of the deep cervical flexor muscles in patients with mechanical neck pain following HVLA thrust manipulation.

It has been suggested that high-velocity displacement of vertebrae with impulse durations of less than 200 milliseconds may alter afferent discharge rates[79] by stimulating mechanoreceptors in the zygapophyseal joint capsule, spinal ligaments, intervertebral disc, and proprioceptors in the muscle spindles and golgi tendon organs within the muscle belly and tendon, thereby changing alpha motor neuron excitability levels and subsequent muscle activity.[26,28,33,45,47,67,69,79,89-91] Furthermore, and in reference to the improved deep cervical flexor motor performance found in our study, it has been hypothesized that HVLA thrust manipulation might stimulate receptors in the deep paraspinal musculature and nonthrust mobilization might be more likely to facilitate receptors in the superficial muscles.[9]

### Limitations

One limitation to the current study is the lack of a long-term follow-up. Patients in this study returned to the clinic for only a 48-hour follow-up. Although significant differences were recognized between groups at this time, it is not known if these benefits would have carried on for a longer period. We also used a treatment approach that was standardized; that is, we administered treatment to only the upper cervical (C1-2) and upper thoracic (T1-2) articulations on all subjects, and we only used 2 rotatory and translatory HVLA thrust manipulation techniques and 2 nonthrust grade IV PA mobilization techniques. Although it has been suggested that the particular HVLA thrust manipulation technique selected may not matter,[20,93] we cannot be certain that these results are generalizable to other kinds of HVLA thrust manipulation techniques. Furthermore, we only used one 30-second bout of nonthrust mobilizations to each side and region, which may not be considered adequate to result in clinical improvements. However, there is no high-quality evidence to date to suggest that more sets and more repetitions of nonthrust mobilization result in greater pain reduction than shorter durations or smaller dosages of nonthrust mobilization.[38,72] Lastly, it was not feasible to blind the patient and treating therapist in a trial such as this, which might also be considered a limitation. Future studies should examine different techniques provided for varying durations and include a long-term follow-up.

## CONCLUSION

THE RESULTS OF THE CURRENT STUDY demonstrated that patients with mechanical neck pain who received the combination of upper cervical and upper thoracic HVLA thrust manipulation, experienced greater reduction in pain and disability, showed greater improvement in passive C1-2 rotation range of motion, and had greater increases in motor performance of the deep cervical flexor muscles, as compared to the group that received nonthrust mobilization at a 48-hour follow-up visit. Future studies should examine the effectiveness of different types and dosages of manual therapy and include long-term follow-up data collection. ◉

## KEY POINTS

**FINDINGS:** Patients who were treated with HVLA thrust manipulation to both the upper cervical (C1-2) and upper thoracic (T1-2) articulations had greater improvements in disability, pain, atlantoaxial ROM, and motor performance of the deep cervical flexor muscles than patients who received nonthrust mobilization directed to the same regions at a 48-hour follow-up.

**IMPLICATION:** The combination of HVLA thrust manipulation procedures directed to both the upper cervical and upper thoracic articulations may enhance the overall outcomes of patients with mechanical neck pain.

**CAUTION:** We only examined the short-term follow-up; therefore, it is not known if the benefits of HVLA thrust manipulation would be maintained in the long term.

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## REFERENCES


1. Amiri M, Jull G, Bullock-Saxton J. Measuring range of active cervical rotation in a position of full head flexion using the 3D Fastrak measurement system: an intra-tester reliability study. *Man Ther*. 2003;8:176-179.
2. Beffa R, Mathews R. Does the adjustment cavitate the targeted joint? An investigation into the location of cavitation sounds. *J Manipulative Physiol Ther*. 2004;27:e2. http://dx.doi.org/10.1016/j.jmpt.2003.12.014
3. Bialosky JE, Bishop MD, Price DD, Robinson ME, George SZ. The mechanisms of manual therapy in the treatment of musculoskeletal pain: a comprehensive model. *Man Ther*. 2009;14:531-538. http://dx.doi.org/10.1016/j.math.2008.09.001
4. Bialosky JE, Bishop MD, Robinson ME, Barabas JA, George SZ. The influence of expectation on spinal manipulation induced hypoalgesia: an experimental study in normal subjects. *BMC Musculoskelet Disord*. 2008;9:19. http://dx.doi.org/10.1186/1471-2474-9-19
5. Bialosky JE, Bishop MD, Robinson ME, George SZ. The relationship of the audible pop to hypoalgesia associated with high-velocity, low-amplitude thrust manipulation: a secondary analysis of an experimental study in pain-free participants. *J Manipulative Physiol Ther*. 2010;33:117-124. http://dx.doi.org/10.1016/j.jmpt.2009.12.008
6. Bialosky JE, George SZ, Bishop MD. How spinal manipulative therapy works: why ask why? *J Orthop Sports Phys Ther*. 2008;38:293-295. http://dx.doi.org/10.2519/jospt.2008.0118
7. Bicalho E, Setti JA, Macagnan J, Cano JL, Manffra EF. Immediate effects of a high-velocity spine manipulation in paraspinal muscles activity of nonspecific chronic low-back pain subjects. *Man Ther*. 2010;15:469-475. http://dx.doi.org/10.1016/j.math.2010.03.012
8. Bishop MD, Beneciuk JM, George SZ. Immediate reduction in temporal sensory summation after thoracic spinal manipulation. *Spine J*. 2011;11:440-446. http://dx.doi.org/10.1016/j.spinee.2011.03.001
9. Bolton PS, Budgell BS. Spinal manipulation and spinal mobilization influence different axial sensory beds. *Med Hypotheses*. 2006;66:258-262. http://dx.doi.org/10.1016/j.mehy.2005.08.054
10. Boyles RE, Walker MJ, Young BA, Strunce J, Wainner RS. The addition of cervical thrust manipulations to a manual physical therapy approach in patients treated for mechanical neck pain: a secondary analysis. *J Orthop Sports Phys Ther*. 2010;40:133-140. http://dx.doi.org/10.2519/jospt.2010.3106
11. Byfield D. *Chiropractic Manipulative Skills*. 2nd ed. Oxford, UK: Churchill Livingstone; 1996.
12. Carlesso LC, Gross AR, Santaguida PL, Burnie S, Voth S, Sadi J. Adverse events associated with the use of cervical manipulation and mobilization for the treatment of neck pain in adults: a systematic review. *Man Ther*. 2010;15:434-444. http://dx.doi.org/10.1016/j.math.2010.02.006
13. Carlesso LC, Macdermid JC, Santaguida LP. Standardization of adverse event terminology and reporting in orthopaedic physical therapy: application to the cervical spine. *J Orthop Sports Phys Ther*. 2010;40:455-463. http://dx.doi.org/10.2519/jospt.2010.3229
14. Cassidy JD, Boyle E, Cote P, et al. Risk of vertebrobasilar stroke and chiropractic care: results of a population-based case-control and case-crossover study. *Spine (Phila Pa 1976)*. 2008;33:S176-183. http://dx.doi.org/10.1097/BRS.0b013e3181644600
15. Cassidy JD, Lopes AA, Yong-Hing K. The immediate effect of manipulation versus mobilization on pain and range of motion in the cervical spine: a randomized controlled trial. *J Manipulative Physiol Ther*. 1992;15:570-575.
16. Chiu TT, Law EY, Chiu TH. Performance of the craniocervical flexion test in subjects with and without chronic neck pain. *J Orthop Sports Phys Ther*. 2005;35:567-571. http://dx.doi.org/10.2519/jospt.2005.2055
17. Cleland JA, Childs JD, Fritz JM, Whitman JM,

Eberhart SL. Development of a clinical prediction rule for guiding treatment of a subgroup of patients with neck pain: use of thoracic spine manipulation, exercise, and patient education. *Phys Ther*. 2007;87:9-23. http://dx.doi.org/10.2522/ptj.20060155

**18.** Cleland JA, Childs JD, McRae M, Palmer JA, Stowell T. Immediate effects of thoracic manipulation in patients with neck pain: a randomized clinical trial. *Man Ther*. 2005;10:127-135. http://dx.doi.org/10.1016/j.math.2004.08.005

**19.** Cleland JA, Childs JD, Whitman JM. Psychometric properties of the Neck Disability Index and Numeric Pain Rating Scale in patients with mechanical neck pain. *Arch Phys Med Rehabil*. 2008;89:69-74. http://dx.doi.org/10.1016/j.apmr.2007.08.126

**20.** Cleland JA, Fritz JM, Kulig K, et al. Comparison of the effectiveness of three manual physical therapy techniques in a subgroup of patients with low back pain who satisfy a clinical prediction rule: a randomized clinical trial. *Spine (Phila Pa 1976)*. 2009;34:2720-2729. http://dx.doi.org/10.1097/BRS.0b013e3181b48809

**21.** Cleland JA, Glynn P, Whitman JM, Eberhart SL, MacDonald C, Childs JD. Short-term effects of thrust versus nonthrust mobilization/manipulation directed at the thoracic spine in patients with neck pain: a randomized clinical trial. *Phys Ther*. 2007;87:431-440. http://dx.doi.org/10.2522/ptj.20060217

**22.** Cleland JA, Mintken PE, Carpenter K, et al. Examination of a clinical prediction rule to identify patients with neck pain likely to benefit from thoracic spine thrust manipulation and a general cervical range of motion exercise: multi-center randomized clinical trial. *Phys Ther*. 2010;90:1239-1250. http://dx.doi.org/10.2522/ptj.20100123

**23.** Clements B, Gibbons P, McLaughlin P. The amelioration of atlanto-axial rotation asymmetry using high velocity low amplitude manipulation: is the direction of thrust important? *J Osteopath Med*. 2001;4:8-14.

**24.** Cote P, Cassidy JD, Carroll LJ, Kristman V. The annual incidence and course of neck pain in the general population: a population-based cohort study. *Pain*. 2004;112:267-273. http://dx.doi.org/10.1016/j.pain.2004.09.004

**25.** Cross KM, Kuenze C, Grindstaff TL, Hertel J. Thoracic spine thrust manipulation improves pain, range of motion, and self-reported function in patients with mechanical neck pain: a systematic review. *J Orthop Sports Phys Ther*. 2011;41:633-642. http://dx.doi.org/10.2519/jospt.2011.3670

**26.** Dishman JD, Bulbulian R. Spinal reflex attenuation associated with spinal manipulation. *Spine (Phila Pa 1976)*. 2000;25:2519-2524;discussion 2525.

**27.** Dumas JL, Sainte Rose M, Dreyfus P, Goldlust D, Chevrel JP. Rotation of the cervical spinal column: a computed tomography in vivo study. *Surg Radiol Anat*. 1993;15:333-339.

**28.** Dunning J, Rushton A. The effects of cervical high-velocity low-amplitude thrust manipulation on resting electromyographic activity of the biceps brachii muscle. *Man Ther*. 2009;14:508-513. http://dx.doi.org/10.1016/j.math.2008.09.003

**29.** Falla D, Bilenkij G, Jull G. Patients with chronic neck pain demonstrate altered patterns of muscle activation during performance of a functional upper limb task. *Spine (Phila Pa 1976)*. 2004;29:1436-1440.

**30.** Falla D, Jull G, Dall'Alba P, Rainoldi A, Merletti R. An electromyographic analysis of the deep cervical flexor muscles in performance of craniocervical flexion. *Phys Ther*. 2003;83:899-906.

**31.** Falla D, Jull G, Hodges PW. Feedforward activity of the cervical flexor muscles during voluntary arm movements is delayed in chronic neck pain. *Exp Brain Res*. 2004;157:43-48. http://dx.doi.org/10.1007/s00221-003-1814-9

**32.** Fernandez-de-las-Penas C, Perez-de-Heredia M, Molero-Sanchez A, Miangolarra-Page JC. Performance of the craniocervical flexion test, forward head posture, and headache clinical parameters in patients with chronic tension-type headache: a pilot study. *J Orthop Sports Phys Ther*. 2007;37:33-39.

**33.** Fritz JM, Koppenhaver S, Kawchuk G, Teyhen D, Hebert J, Childs JD. Preliminary investigation of the mechanisms underlying the effects of manipulation: exploration of a multi-variate model including spinal stiffness, multifidus recruitment, and clinical findings. *Spine (Phila Pa 1976)*. 2011;36:1772-1781.

**34.** George SZ, Bishop MD, Bialosky JE, Zeppieri G, Jr., Robinson ME. Immediate effects of spinal manipulation on thermal pain sensitivity: an experimental study. *BMC Musculoskelet Disord*. 2006;7:68. http://dx.doi.org/10.1186/1471-2474-7-68

**35.** Gibbons P, Tehan P. *Manipulation of the Spine, Thorax and Pelvis: An Osteopathic Perspective*. Edinburgh, UK: Churchill-Livingstone; 2000.

**36.** Gonzalez-Iglesias J, Fernandez-de-las-Penas C, Cleland JA, Alburquerque-Sendin F, Palomeque-del-Cerro L, Mendez-Sanchez R. Inclusion of thoracic spine thrust manipulation into an electro-therapy/thermal program for the management of patients with acute mechanical neck pain: a randomized clinical trial. *Man Ther*. 2009;14:306-313. http://dx.doi.org/10.1016/j.math.2008.04.006

**37.** Gonzalez-Iglesias J, Fernandez-de-las-Penas C, Cleland JA, Gutierrez-Vega Mdel R. Thoracic spine manipulation for the management of patients with neck pain: a randomized clinical trial. *J Orthop Sports Phys Ther*. 2009;39:20-27. http://dx.doi.org/10.2519/jospt.2009.2914

**38.** Gross A, Miller J, D'Sylva J, et al. Manipulation or mobilisation for neck pain: a Cochrane Review. *Man Ther*. 2010;15:315-333. http://dx.doi.org/10.1016/j.math.2010.04.002

**39.** Haavik-Taylor H, Murphy B. Cervical spine manipulation alters sensorimotor integration: a somatosensory evoked potential study. *Clin Neurophysiol*. 2007;118:391-402. http://dx.doi.org/10.1016/j.clinph.2006.09.014

**40.** Haldeman S, Kohlbeck FJ, McGregor M. Unpredictability of cerebrovascular ischemia associated with cervical spine manipulation therapy: a review of sixty-four cases after cervical spine manipulation. *Spine (Phila Pa 1976)*. 2002;27:49-55.

**41.** Hall T, Robinson K. The flexion-rotation test and active cervical mobility--a comparative measurement study in cervicogenic headache. *Man Ther*. 2004;9:197-202. http://dx.doi.org/10.1016/j.math.2004.04.004

**42.** Hall TM, Briffa K, Hopper D, Robinson K. Comparative analysis and diagnostic accuracy of the cervical flexion-rotation test. *J Headache Pain*. 2010;11:391-397. http://dx.doi.org/10.1007/s10194-010-0222-3

**43.** Hall TM, Robinson KW, Fujinawa O, Akasaka K, Pyne EA. Intertester reliability and diagnostic validity of the cervical flexion-rotation test. *J Manipulative Physiol Ther*. 2008;31:293-300. http://dx.doi.org/10.1016/j.jmpt.2008.03.012

**44.** Hartman L. *Handbook of Osteopathic Technique*. 3rd ed. Cheltenham, UK: Nelson-Thornes; 2001.

**45.** Herzog W, Scheele D, Conway PJ. Electromyographic responses of back and limb muscles associated with spinal manipulative therapy. *Spine (Phila Pa 1976)*. 1999;24:146-152; discussion 153.

**46.** Hurwitz EL, Morgenstern H, Harber P, Kominski GF, Yu F, Adams AH. A randomized trial of chiropractic manipulation and mobilization for patients with neck pain: clinical outcomes from the UCLA neck-pain study. *Am J Public Health*. 2002;92:1634-1641.

**47.** Indahl A, Kaigle AM, Reikeras O, Holm SH. Interaction between the porcine lumbar intervertebral disc, zygapophysial joints, and paraspinal muscles. *Spine (Phila Pa 1976)*. 1997;22:2834-2840.

**48.** Jaeschke R, Singer J, Guyatt GH. Measurement of health status. Ascertaining the minimal clinically important difference. *Control Clin Trials*. 1989;10:407-415.

**49.** Jensen MP, Karoly P, Braver S. The measurement of clinical pain intensity: a comparison of six methods. *Pain*. 1986;27:117-126.

**50.** Johansson H, Sojka P. Pathophysiological mechanisms involved in genesis and spread of muscular tension in occupational muscle pain and in chronic musculoskeletal pain syndromes: a hypothesis. *Med Hypotheses*. 1991;35:196-203.

**51.** Jull G. Deep cervical flexor muscle dysfunction in whiplash. *J Musculoskelet Pain*. 2000;8:143-154.

**52.** Jull G, Kristjansson E, Dall'Alba P. Impairment in the cervical flexors: a comparison of whiplash and insidious onset neck pain patients. *Man Ther*. 2004;9:89-94. http://dx.doi.org/10.1016/S1356-689X(03)00086-9

**53.** Jull G, Trott P, Potter H, et al. A randomized controlled trial of exercise and manipulative therapy for cervicogenic headache. *Spine (Phila*

*Pa 1976)*. 2002;27:1835-1843; discussion 1843.
**54.** Jull G, Zito G, Trott P, Potter H, Shirley D. Inter-examiner reliability to detect painful upper cervical joint dysfunction. *Aust J Physiother*. 1997;43:125-129.
**55.** Keller TS, Colloca CJ. Mechanical force spinal manipulation increases trunk muscle strength assessed by electromyography: a comparative clinical trial. *J Manipulative Physiol Ther*. 2000;23:585-595. http://dx.doi.org/10.1067/mmt.2000.110947
**56.** Kerry R, Taylor AJ. Cervical arterial dysfunction assessment and manual therapy. *Man Ther*. 2006;11:243-253. http://dx.doi.org/10.1016/j.math.2006.09.006
**57.** Kerry R, Taylor AJ, Mitchell J, McCarthy C, Brew J. Manual therapy and cervical arterial dysfunction, directions for the future: a clinical perspective. *J Man Manip Ther*. 2008;16:39-48.
**58.** Knutson GA. Significant changes in systolic blood pressure post vectored upper cervical adjustment vs resting control groups: a possible effect of the cervicosympathetic and/or pressor reflex. *J Manipulative Physiol Ther*. 2001;24:101-109. http://dx.doi.org/10.1067/mmt.2001.112564
**59.** Krauss J, Creighton D, Ely JD, Podlewska-Ely J. The immediate effects of upper thoracic translatoric spinal manipulation on cervical pain and range of motion: a randomized clinical trial. *J Man Manip Ther*. 2008;16:93-99.
**60.** Lau HM, Wing Chiu TT, Lam TH. The effectiveness of thoracic manipulation on patients with chronic mechanical neck pain - a randomized controlled trial. *Man Ther*. 2011;16:141-147. http://dx.doi.org/10.1016/j.math.2010.08.003
**61.** Leaver AM, Maher CG, Herbert RD, et al. A randomized controlled trial comparing manipulation with mobilization for recent onset neck pain. *Arch Phys Med Rehabil*. 2010;91:1313-1318. http://dx.doi.org/10.1016/j.apmr.2010.06.006
**62.** Lee R, Evans J. An in vivo study of the intervertebral movements produced by posteroanterior mobilization. *Clin Biomech (Bristol, Avon)*. 1997;12:400-408.
**63.** Licht PB, Christensen HW, Hoilund-Carlsen PF. Is there a role for premanipulative testing before cervical manipulation? *J Manipulative Physiol Ther*. 2000;23:175-179.
**64.** MacDermid JC, Walton DM, Avery S, et al. Measurement properties of the neck disability index: a systematic review. *J Orthop Sports Phys Ther*. 2009;39:400-417. http://dx.doi.org/10.2519/jospt.2009.2930
**65.** Magarey ME, Rebbeck T, Coughlan B, Grimmer K, Rivett DA, Refshauge K. Pre-manipulative testing of the cervical spine review, revision and new clinical guidelines. *Man Ther*. 2004;9:95-108. http://dx.doi.org/10.1016/j.math.2003.12.002
**66.** Maitland GD. *Vertebral Manipulation*. 5th ed. London, UK: Butterworth & Co Ltd; 1986.
**67.** Marshall P, Murphy B. The effect of sacroiliac joint manipulation on feed-forward activation times of the deep abdominal musculature. *J Manipulative Physiol Ther*. 2006;29:196-202. http://dx.doi.org/10.1016/j.jmpt.2006.01.010
**68.** Martinez-Segura R, Fernandez-de-las-Penas C, Ruiz-Saez M, Lopez-Jimenez C, Rodriguez-Blanco C. Immediate effects on neck pain and active range of motion after a single cervical high-velocity low-amplitude manipulation in subjects presenting with mechanical neck pain: a randomized controlled trial. *J Manipulative Physiol Ther*. 2006;29:511-517. http://dx.doi.org/10.1016/j.jmpt.2006.06.022
**69.** Metcalfe S, Reese H, Sydenham R. Effect of high-velocity low-amplitude manipulation on cervical spine muscle strength. *J Man Manip Ther*. 2006;14:152-158.
**70.** Millan MJ. Descending control of pain. *Prog Neurobiol*. 2002;66:355-474.
**71.** Mimura M, Moriya H, Watanabe T, Takahashi K, Yamagata M, Tamaki T. Three-dimensional motion analysis of the cervical spine with special reference to the axial rotation. *Spine (Phila Pa 1976)*. 1989;14:1135-1139.
**72.** Moss P, Sluka K, Wright A. The initial effects of knee joint mobilization on osteoarthritic hyperalgesia. *Man Ther*. 2007;12:109-118. http://dx.doi.org/10.1016/j.math.2006.02.009
**73.** Norlander S, Aste-Norlander U, Nordgren B, Sahlstedt B. Mobility in the cervico-thoracic motion segment: an indicative factor of musculo-skeletal neck-shoulder pain. *Scand J Rehabil Med*. 1996;28:183-192.
**74.** Norlander S, Gustavsson BA, Lindell J, Nordgren B. Reduced mobility in the cervico-thoracic motion segment--a risk factor for musculoskeletal neck-shoulder pain: a two-year prospective follow-up study. *Scand J Rehabil Med*. 1997;29:167-174.
**75.** Norlander S, Nordgren B. Clinical symptoms related to musculoskeletal neck-shoulder pain and mobility in the cervico-thoracic spine. *Scand J Rehabil Med*. 1998;30:243-251.
**76.** Nygren A, Berglund A, von Koch M. Neck-and-shoulder pain, an increasing problem. Strategies for using insurance material to follow trends. *Scand J Rehabil Med Suppl*. 1995;32:107-112.
**77.** Ogince M, Hall T, Robinson K, Blackmore AM. The diagnostic validity of the cervical flexion-rotation test in C1/2-related cervicogenic headache. *Man Ther*. 2007;12:256-262. http://dx.doi.org/10.1016/j.math.2006.06.016
**78.** Parkin-Smith GF, Penter C. A clinical trial investigating the effect of two manipulative approaches in the treatment of mechanical neck pain: a pilot study. *J Neuromusculoskel Syst*. 1998;6:6-16.
**79.** Pickar JG, Kang YM. Paraspinal muscle spindle responses to the duration of a spinal manipulation under force control. *J Manipulative Physiol Ther*. 2006;29:22-31. http://dx.doi.org/10.1016/j.jmpt.2005.11.014
**80.** Puentedura EJ, Landers MR, Cleland JA, Mintken PE, Huijbregts P, Fernandez-de-Las-Penas C. Thoracic spine thrust manipulation versus cervical spine thrust manipulation in patients with acute neck pain: a randomized clinical trial. *J Orthop Sports Phys Ther*. 2011;41:208-220. http://dx.doi.org/10.2519/jospt.2011.3640
**81.** Raney NH, Petersen EJ, Smith TA, et al. Development of a clinical prediction rule to identify patients with neck pain likely to benefit from cervical traction and exercise. *Eur Spine J*. 2009;18:382-391. http://dx.doi.org/10.1007/s00586-008-0859-7
**82.** Ross JK, Bereznick DE, McGill SM. Determining cavitation location during lumbar and thoracic spinal manipulation: is spinal manipulation accurate and specific? *Spine (Phila Pa 1976)*. 2004;29:1452-1457.
**83.** Rothwell DM, Bondy SJ, Williams JI. Chiropractic manipulation and stroke: a population-based case-control study. *Stroke*. 2001;32:1054-1060.
**84.** Savolainen A, Ahlberg J, Nummila H, Nissinen M. Active or passive treatment for neck-shoulder pain in occupational health care? A randomized controlled trial. *Occup Med (Lond)*. 2004;54:422-424. http://dx.doi.org/10.1093/occmed/kqh070
**85.** Sillevis R, Cleland J. Immediate effects of the audible pop from a thoracic spine thrust manipulation on the autonomic nervous system and pain: a secondary analysis of a randomized clinical trial. *J Manipulative Physiol Ther*. 2011;34:37-45. http://dx.doi.org/10.1016/j.jmpt.2010.11.007
**86.** Skyba DA, Radhakrishnan R, Rohlwing JJ, Wright A, Sluka KA. Joint manipulation reduces hyperalgesia by activation of monoamine receptors but not opioid or GABA receptors in the spinal cord. *Pain*. 2003;106:159-168.
**87.** Smith WS, Johnston SC, Skalabrin EJ, et al. Spinal manipulative therapy is an independent risk factor for vertebral artery dissection. *Neurology*. 2003;60:1424-1428.
**88.** Suter E, McMorland G. Decrease in elbow flexor inhibition after cervical spine manipulation in patients with chronic neck pain. *Clin Biomech (Bristol, Avon)*. 2002;17:541-544.
**89.** Suter E, McMorland G, Herzog W. Short-term effects of spinal manipulation on H-reflex amplitude in healthy and symptomatic subjects. *J Manipulative Physiol Ther*. 2005;28:667-672. http://dx.doi.org/10.1016/j.jmpt.2005.09.017
**90.** Suter E, McMorland G, Herzog W, Bray R. Conservative lower back treatment reduces inhibition in knee-extensor muscles: a randomized controlled trial. *J Manipulative Physiol Ther*. 2000;23:76-80.
**91.** Symons BP, Herzog W, Leonard T, Nguyen H. Reflex responses associated with activator treatment. *J Manipulative Physiol Ther*. 2000;23:155-159.
**92.** Taylor AJ, Kerry R. The 'vertebral artery test'. *Man Ther*. 2005;10:297; author reply 298. http://dx.doi.org/10.1016/j.math.2005.02.005
**93.** van Schalkwyk R, Parkin-Smith GF. A clinical trial investigating the possible effect of the supine cervical rotatory manipulation and the supine lateral break manipulation in the treat-

ment of mechanical neck pain: a pilot study. *J Manipulative Physiol Ther*. 2000;23:324-331.
**94.** Vernon H, Mior S. The Neck Disability Index: a study of reliability and validity. *J Manipulative Physiol Ther*. 1991;14:409-415.
**95.** Weeks DL, Noteboom JT. Using the number needed to treat in clinical practice. *Arch Phys Med Rehabil*. 2004;85:1729-1731.
**96.** Whitman JM, Cleland JA, Mintken PE, et al. Predicting short-term response to thrust and nonthrust manipulation and exercise in patients post inversion ankle sprain. *J Orthop Sports Phys Ther*. 2009;39:188-200. http://dx.doi.org/10.2519/jospt.2009.2940
**97.** Whittingham W, Nilsson N. Active range of motion in the cervical spine increases after spinal manipulation (toggle recoil). *J Manipulative Physiol Ther*. 2001;24:552-555. http://dx.doi.org/10.1067/mmt.2001.118979
**98.** Wright A, Mayer TG, Gatchel RJ. Outcomes of disabling cervical spine disorders in compensation injuries. A prospective comparison to tertiary rehabilitation response for chronic lumbar spinal disorders. *Spine (Phila Pa 1976)*. 1999;24:178-183.
**99.** Young IA, Cleland JA, Michener LA, Brown C. Reliability, construct validity, and responsiveness of the neck disability index, patient-specific functional scale, and numeric pain rating scale in patients with cervical radiculopathy. *Am J Phys Med Rehabil*. 2010;89:831-839. http://dx.doi.org/10.1097/PHM.0b013e3181ec98e6
**100.** Zito G, Jull G, Story I. Clinical tests of musculoskeletal dysfunction in the diagnosis of cervicogenic headache. *Man Ther*. 2006;11:118-129. http://dx.doi.org/10.1016/j.math.2005.04.007
**101.** Zusman M. Forebrain-mediated sensitization of central pain pathways: 'non-specific' pain and a new image for MT. *Man Ther*. 2002;7:80-88.

# Neck Pain

## *Manipulation of Your Neck and Upper Back Leads to Quicker Recovery*

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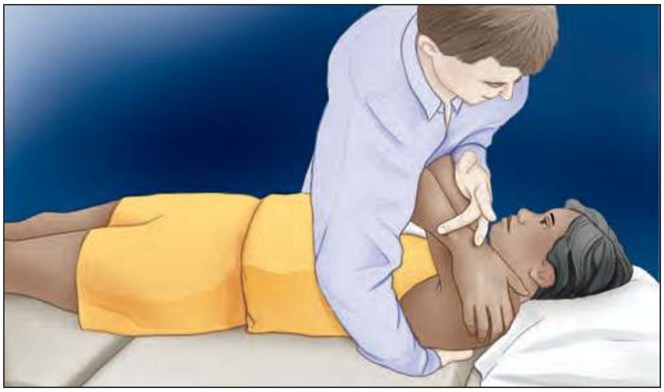
Neck pain is very common and fortunately resolves quickly in most individuals. However, in certain cases neck pain can last longer and result in chronic pain, limited neck motion, and disability. In fact, chronic neck pain is the second leading cause of workers' compensation claims in the United States. Treatments that can quickly reduce pain, increase motion, and improve the ability of the muscles to protect the neck may help decrease long-term disability associated with neck pain. A variety of manual therapy treatments are currently used to manage neck pain. These treatments include mobilization, which slowly and repeatedly moves the neck joints and muscles, and manipulation, which delivers a single, small, quick movement to the joints and muscles. A research report published in the January 2012 issue of *JOSPT* examines the outcomes of these 2 treatment methods and draws conclusions about which one is best.

**UPPER BACK AND NECK MANIPULATIONS.** The drawings to the left and below show how a therapist would treat your neck pain using 2 upper back and upper neck manipulation techniques.



### NEW INSIGHTS

In this study, researchers treated 107 patients. About half of these patients received a manipulation of the neck, on the part closest to the head, and of the upper back. The other patients received manual therapy that mobilized the spine without using manipulation. After 48 hours, the patients who received the manipulation treatment experienced a 58% decrease in pain and a 50% decrease in disability. By contrast, patients who received the mobilization treatment only had a 13% decrease in pain and actually showed a 13% increase in disability. In addition, the patients who received the manipulation had increased motion and improved control of their neck muscles compared to the patients in the mobilization group. The researchers concluded that the combination of upper neck and back manipulation was more effective in the first 48 hours of treatment than the mobilization treatment.

### PRACTICAL ADVICE

Patients with typical neck pain may benefit from a physical therapy program that includes upper neck and upper back manipulation. Potential benefits include less pain, better neck motion, and improved ability to perform daily activities. Although this treatment was very successful for this group of patients with neck pain, it may not be effective or even appropriate for all patients with neck pain. Your physical therapist can perform a thorough evaluation to help determine if you are a good candidate for this treatment, as part of a program designed to help get rid of the aching in your neck. The benefits in this study were only measured for the first 48 hours after treatment; further research is needed to determine long-term benefits. For more information on the treatment of neck pain, contact a physical therapist who specializes in musculoskeletal disorders.

For this and more topics, visit *JOSPT* Perspectives for Patients online at **www.jospt.org**.

This *JOSPT* Perspectives for Patients is based on an article by Dunning JR et al, titled "Upper Cervical and Upper Thoracic Thrust Manipulation Versus Non-Thrust Mobilization in Patients With Mechanical Neck Pain: A Multi-Center Randomized Clinical Trial" (*J Orthop Sports Phys Ther 2012;42(1):5-18. doi:10.2519/jospt.2012.3894*)

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