A preliminary study comparing the use of cervical/upper thoracic mobilization and manipulation for individuals with mechanical neck pain

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Objectives: Neck pain is routinely managed using manual therapy (MT) to the cervical and thoracic spines. While both mobilizations and manipulations to these areas have been shown to reduce neck pain, increase cervical range of motion, and reduce disability, the most effective option remains elusive. The purpose of this preliminary trial was to compare the pragmatic use of cervical and thoracic mobilizations vs. manipulation for mechanical neck pain.

Methods: This trial included 20 patients with mechanical neck pain. Each patient was randomized to receive either mobilization or manipulation to both the cervical and thoracic spines during their plan of care. Within-group analyses were made with Wilcoxon signed-rank tests and between-group analyses were made with Mann-Whitney *U*.

Results: There were no between-group differences for any of the dependent variables including cervical active range of motion (CAROM) ($P=0.18$), deep cervical flexion (DCF) endurance ($P=0.06$), numerical pain rating scale (NPRS) ($P=0.26$), the neck disability index (NDI, $P=0.33$), patient-specific functional scale (PSFS, $P=0.20$), or the global rating of change (GROC) scale ($P=0.94$). Within-group results were significant for all outcome variables ($P<0.001$) from initial evaluation to discharge for both groups.

Discussion: These findings were consistent with other trials previously conducted that applied the MT techniques in a pragmatic fashion, but varied from previous trials where the treatment was standardized. A larger experimental study is necessary to further examine the differences between mobilization and manipulation for neck pain.

Keywords: Mobilizations, Manipulation, Neck pain

Background

Non-specific neck pain has been defined as pain from the superior nuchal line to the first thoracic spinous process.¹ Manual therapy (MT), including joint mobilization and manipulation, is routinely used in the management of mechanical neck pain.²⁻⁴ A joint manipulation is a high velocity low amplitude (HVLA) thrust performed at or near the end range of a targeted segment.⁵ Joint mobilizations are low-grade passive movements with small or large amplitude at a targeted segment.⁵ The effect of MT may result in temporary biomechanical changes,^{6,7} local and regional neurophysiological effects,⁸ as well as alter the inflammatory state that is initiated by injury.⁹

Minor adverse events (AE) from MT include an increase in soreness and stiffness.¹⁰ Serious AE are uncommon following cervical spine HVLA with incidence rates estimated to be 1/50 000.¹¹ Performing pre-manipulative screening procedures related to the prevention of neurovascular injury remains controversial due to poor diagnostic accuracy that occurs with available screening procedures.^{12,13} It has been suggested that a thorough medical screen and sound clinical reasoning can prevent a number of AE from occurring, however, some AE are not preventable.¹⁴

A recent systemic review found that MT reduces pain and disability for patients with non-specific neck pain, and that these effects are enhanced when combined with exercise.⁴ Mobilization and manipulation to the thoracic spine for mechanical neck pain may also be beneficial;¹⁰⁻¹² however, the current evidence for applying MT to both the cervical and thoracic spine is conflicting.^{15,16} Masaracchio *et al.*¹⁵

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reported that patients who received both the cervical mobilizations and thoracic HVLA manipulations reported significantly better outcomes than those who received non-thrust mobilization to the neck only. These findings were consistent with those of Saavedra-Hernandez *et al.*¹⁷ who found that those patients with chronic neck pain who received cervical, cervical–thoracic, and thoracic HVLA had greater reductions in disability scores than those who received cervical HVLA alone. On the contrary, Parkin-Smith¹⁶ reported no difference on pain and disability between patients who received HVLA to the neck vs. those who received HVLA to their neck and thoracic spine.

Neither joint mobilization nor manipulation has demonstrated consistent clinical superiority in the management of neck pain.^{5,18–21} The methods of treatment interventions used in these trials varied in terms of prescriptive vs. pragmatic application. Pragmatic clinical trials are intended to allow clinicians freedom in their clinical decision-making processes, which simulates clinical practice better than a prescriptive trial. Moreover, the randomization process is preserved.²² Two studies that used a pragmatic method for their treatment protocol reported no significant differences between mobilization and manipulation for treating patients with neck pain.^{19,21}

Prescriptive trials, where the care is standardized, may not be as generalizable to clinical practice. The dosages provided in these clinical trials may not be similar to what is used in clinical practice. Moreover, it has been suggested that the patient's treatment should be based on their clinical presentation.²³ A recent study suggested that patients who received a bilateral HVLA directed to C1–C2 and upper thoracic spine improved more than those who received mobilizations at the same levels.¹⁸ This study, however, standardized the mobilization treatment and did not target the treatment to the patient's symptomatic level. Tuttle *et al.*²⁴ reported that a 2-minute bout of mobilization performed at the symptomatic level produced increased active range of motion (AROM) and reduced the degree of stiffness compared to mobilizations applied to asymptomatic levels.

Additionally, recent evidence suggests that specific mobilizations applied to the cervical spine propagates pain reduction better than non-specific mobilizations.²⁵ Specific techniques depend on limitations identified at a specific spinal level that are associated with a patient's chief complaint.²⁵ Targeting the involved level as a necessary component of the treatment remains in question when providing MT treatment for individuals with neck pain. More evidence is needed to determine whether or not a

clinician's choice of MT treatment provides significantly better results than random techniques.

Objectives

The purpose of this study was to compare the effectiveness of spinal mobilizations and manipulations applied to both the cervical and upper thoracic spine for mechanical neck pain when applied pragmatically to the symptomatic level. We hypothesized that there would be no differences in clinical outcomes for patients who received cervical and thoracic mobilizations or manipulation at three time points, after visit 1, visit 2, or at discharge.

Methods

This clinical trial was approved by Youngstown State University's Institutional Review Board and registered with www.clinicaltrials.gov# NCT02036905. Prior to any baseline examination measures, all patients read and signed an informed consent.

Participants

Patients were recruited from two clinic sites and one university between July 2013 and May 2014 through direct solicitation, direct access, and physician referral. For inclusion into the trial, patients had to be 18–70 years old, have a chief complaint of reproducible, non-specific neck pain with a primary location between the supranuchal line and the first thoracic spinous process, and a neck disability index (NDI) score $\geq 20\%$. Patients were excluded if they had a recent significant trauma (including whiplash), malignancy, radiculopathy, myelopathy, fracture, metabolic disease, rheumatoid arthritis, long-term corticosteroid use, or history of neck surgery. Additionally, neck pain of <2 on the numerical pain rating scale (NPRS), a patient-specific functional scale (PSFS) score ≥ 8 on any functional rating, prior treatment within the past 6 weeks, upper limb symptoms, or any pending litigation were exclusion criteria. Finally, patients were removed if the therapist was unable to elicit the chief complaint with passive accessory intervertebral movements (PAIVM).

Treating therapists

Three physical therapists with an average of $19 (\pm 9.6)$ years clinical experience participated in data collection for this study. Each investigator was required to have at least 5 years of clinical experience and each were certified orthopedic manual therapists (COMT). Investigators were familiar with the examination procedures aimed at identifying the symptomatic level through pain provocation and were adequately trained in providing the treatment techniques. In order to enhance consistency with the intended study methods, each investigator followed a specific study protocol during data collection. The same investigator followed up with the patients at each follow-up

session and all treating therapists were blinded to the results of the outcome measures. Description for each of the techniques was documented for each patient at the initial treatment session, second follow-up visit, and at discharge. Finally, the therapist documented any additional treatments that were added to the patient's plan of care after the second visit.

Examination

Each patient was individually screened for eligibility by the treating physical therapist. Patients filled out their demographic information and completed the self-report outcome tools that included the NDI, the PSFS, and the NPRS. A data-collecting therapist collected outcome measures and was blinded to group assignment. A comprehensive physical therapy examination was performed on each patient that included cervical AROM (CAROM), PAIVM, strength, palpation, and deep cervical flexion (DCF) endurance testing. In addition, clinicians were able to incorporate any orthopedic or neurological test they deemed appropriate to assist with their decision-making and to ensure that all patients fit the study criteria. Passive accessory intervertebral movements were performed with the purpose of pain provocation in order to determine the most likely involved segment of the neck. Although PAIVM have been shown to lack specificity in terms of segmental movement in the spine,^{26,27} pain provocation has been suggested to be the most reliable method when isolating the site of the disorder.²⁸ Finally, thoracic spine range of motion assessment and joint play testing was performed to identify segmental hypomobility or symptom provocation.

Randomization

Each patient was randomized to either the manipulation or mobilization group using a coin flip following baseline examination procedures that determined eligibility. Patients were treated according to their group assignment for the first two visits of care. Following the second visit, clinicians could change manual treatment if the therapist determined this to be appropriate.

Interventions

The plan of care for each patient was individualized based on their clinical presentation and the discretion of the treating therapist. The decision-making process included selecting the type of technique, dosage, and the plan of care for each patient. Clinicians targeted treatment at a single level of the cervical and thoracic spine that was found to be the most symptomatic level. The use of posterior-anterior (PA) movements during passive intervertebral joint play was used to identify the most symptomatic level. The segment targeted for either the mobilization or manipulation was based on the reproduction of the concordant sign

with the PAIVM done as a central PA (CPA) glide or a unilateral PA (UPA) glide.

Manipulation group

The treating therapist delivered a HVLA thrust to the most symptomatic segment of both the cervical and upper thoracic spine. The type of thrust was determined based on the patient's presentation and the clinical reasoning of the treating therapist. For the cervical HVLA, the thrust was provided in the direction of therapist's choice and was performed only once if an audible was present. The technique selected most often was a rotational HVLA thrust.²⁹ If no audible occurred, the thrust was repeated. If there was no audible after the second attempt, the thrust was repeated in the opposite direction up to two times in order to obtain the audible. For the thoracic spine, up to two attempts was used to obtain the desired audible. Only one level of the thoracic spine was targeted for treatment. The therapists selected either a 'pistol grip' HVLA with the patient positioned in supine or a bilateral PA HVLA with the patient positioned in prone.²⁹

Mobilization group

Patients who were allocated to the mobilization group received the MT treatment to both the cervical and thoracic spine. The type of cervical mobilization and dosage was based on the patient's presentation and feedback, as well as the therapist's clinical decisions, but it was only applied to the most symptomatic level. Any form of mobilization was permitted and the therapist was able to provide the technique anywhere in range and for any duration, thought to produce a positive patient response. The therapist again selected the thoracic mobilization technique, grade, and dosage. For both the cervical and thoracic spine, the treating therapists most commonly selected either a grade III or IV CPA, UPA, or bilateral UPA mobilization as described by Maitland.²⁹

Other treatments

In addition to MT, all patients received a standardized home exercise program (HEP) that included AROM exercises for the cervical and thoracic spine and DCF exercises. The cervical and thoracic AROM exercises were performed three times daily for two sets of 10. The DCF exercise' parameters were prescribed based on the patient's ability to perform the exercise correctly. Clinicians also provided each patient with patient education, advice, and encouragement. The frequency, duration, and number of visits for each patient were individualized based on the need determined by each clinician.

Outcome measures

The primary outcome was the NDI. The NDI is a self-report measure of perceived disability and it

includes 10 questions using an ordinal scale from 0 to 5 for a maximum of 50 points. The higher an individual scores on the NDI, the greater their perceived level of disability. The NDI has acceptable reliability and validity for patients with neck pain.³⁰ The minimal detectable change (MDC) is a 20% change,^{31–34} and the minimal clinically important difference (MCID) is a 14% change.³⁰ The NDI was collected at baseline, at visit 2, and at discharge.

Secondary outcome measures included the PSFS, NPRS, cervical AROM (CAROM), DCF, and the global rating of change (GROC). The PSFS measures general activity limitations. The scale ranges from 0 (unable to perform) to 10 (able to perform the activity at the level prior to injury). The patient reports three activities that are limited due to the current injury and an average rating for all three activities is calculated. The PSFS has excellent test–retest reliability (ICC=0.92) and a standard error of measure of 0.43 for patients with neck pain.³⁵ The MDC of the PSFS for patients with neck dysfunction is two points.³⁵ The PSFS was collected at baseline, at the second visit follow-up, and at discharge.

The patients' pain level was assessed by the NPRS. The NPRS is an 11-point scale ranging from 0 (no pain) to 10 (worst imaginable pain). Three separate pain ratings were collected (current, best, and worst), experienced over 24 hours, and then averaged for a composite score. The NPRS has an MDC of 2.1 and an MCID of 1.3 in patients with mechanical neck pain.³² Numerical pain rating scale' scores were collected at baseline, after the initial treatment, before and after the second treatment, and at discharge.

The GROC is a 15-point scale used to quantify a patient's improvement with treatment or to record the clinical course of a condition over time.³⁶ Patients are asked to describe their overall condition since the start of treatment until the present time with options ranging from –7 (a very great deal worse) to +7 (a very great deal better) and 0 being described as 'about the same'. Stratford *et al.*³⁷ found a five point change to be important. Global rating of change scores were collected immediately after the initial treatment session, pre- and post-treatment at the second visit, and at discharge.

The procedure for measuring DCF endurance was adopted from Grimmer.³⁸ Each patient was positioned in supine and was instructed to maximally tuck his/her chin isometrically. Patients were then instructed to lift their head 2.5 cm off the plinth and to maintain upper cervical flexion simultaneously for as long as they were able. A skin fold along the antero-lateral neck was monitored and the investigator's hand remained under the occiput of the patient for tactile cueing. The timing of the position began once the patient was in the correct position and

stopped if the patient's head dropped into the fingers of the clinician, elevated their head greater than 1 inch, lost the skin fold on the antero-lateral neck, or the patient was unable to continue.³⁸ Interrater reliability is moderate (ICC_{3,1}=0.67) for clinical testing on patients with neck pain.³⁹ Deep cervical flexion endurance was recorded in seconds and collected at baseline, immediately following the initial treatment, pre- and post-treatment at visit two, and at discharge.

Active range of motion was measured using a universal goniometer. The movement that produced the chief complaint with the least amount of movement was measured. When measured with a universal goniometer, cervical AROM has good to high intrarater reliability (ICC≥0.78).⁴⁰ All cervical ranges of motion measurements were recorded in degrees and collected at baseline, immediately following the first treatment, at second visit follow-up, immediately following the second treatment, and at discharge.

Data analysis

Between-groups baseline characteristics were analyzed with Mann–Whitney *U* for continuous variables (NDI, PSFS, CAROM, DCF, and NPRS at baseline, after visit 2, and at discharge) and chi square tests for categorical variables (sex). Non-parametric analyses were used because the data were not normally distributed. Within-group changes were analyzed for all outcome measures using Wilcoxon signed-rank test. For all analyses, a *P*-value of <0.05 was considered significant. All analyses were performed using SPSS version 20 (IBM, Armonk, NY, USA).

Results

Twenty-two patients were screened for eligibility and enrolled in the study but only 20 patients were included in the final data analysis. One was lost after the second follow-up and one patient did not return for his/her final visit. Seven were randomized to the manipulation group and 13 to the mobilization group. See Fig. 1 for a flow diagram of patient recruitment and retention. Baseline characteristics and outcome variables were not different between-groups (Table 1). There were no significant between-group differences for the number of visits they received, nor were there any significant differences at the second visit follow-up or at discharge between the two groups for the outcomes of interest (Table 2, see Figs. 2 and 3). The Wilcoxon signed rank test found significant within-group changes for both groups combined on the NDI (*P*<0.001), PSFS (*P*<0.001), NPRS (*P*<0.001), CAROM (*P*<0.001), and DCF (*P*<0.001) from baseline to discharge. The GROC was also significant (*P*<0.001) post-treatment one to discharge for both groups. At discharge, both groups reported mean change scores of 39% (±12.2%)

Figure 1 CONSORT flow diagram for patient randomization and retainment.

on the NDI, 4 points (± 1.2) for PSFS, 3.9 point (± 1.4) change on the NPRS, 22.05 seconds (± 12.05) change for the DCF, 19.9° (± 21.4) for CAROM, and an average change score for the GROC at discharge of

5.5 (± 1.1). A total of five patients, four from the HVLA and one from the mobilization group, reported minor AE that included transient soreness or stiffness.

Table 1 Patients' baseline characteristics and outcome variables (N=20)

Patients' baseline characteristics	Mobilization group (N=13) mean (SD)	Manipulation group (N=7) mean (SD)	P-value
Sex	7=males 6=females	2=males 5=females	0.28 [†]
Age (years)	41.2 (14.6)	37.4 (15.7)	0.55
Height (inch)	70.1 (2.8)	65.5 (2.1)	0.06
Weight (lbs.)	185 (40.1)	148 (27.3)	0.10
Baseline NDI (%)	31.1 (11.7)	34.2 (17.8)	0.81
Baseline PSFS score	4.5 (1.67)	4.0 (.8)	0.31
Baseline NPRS	5.2(2.2)	5.6 (2.7)	0.78
Baseline CAROM (degree)	40.4 (20.5)	31.2 (26.8)	0.41
Baseline DCF (second)	17.0 (15.8)	10.6 (14.4)	0.35

[†] Chi square.

Mann-Whitney U.

NDI: neck disability index (%); PSFS: patient-specific functional scale score; NPRS: numerical pain rating scale; CAROM: cervical active range of motion; DCF: deep cervical flexion..

Figure 2 Between-group comparison for means % scores on the neck disability index (NDI) at baseline, second visit, and discharge. Error bars represent the 95% confidence interval for each mean score. No time point was statistically significant between-groups.

Discussion

This preliminary RCT is the first pragmatically applied comparison of the effect of combined cervical and thoracic mobilizations to combined cervical and thoracic manipulation, targeting the symptomatic level, for mechanical neck pain. This study found that both MT treatments resulted in clinically important improvements without between-group differences.

Currently, there is limited evidence exploring the benefits of clinician's choice vs. randomly selected MT techniques for treating mechanical neck pain. A meta-analysis found that there was insufficient data to support the use of MT techniques selected by the treating therapist over using random techniques for non-specific low back pain. However, the authors concluded that the evidence is limited by the lack of quality studies.⁴¹

The results from this preliminary study showed that no difference existed between mobilization and manipulation when applied to the symptomatic level of both the cervical and upper thoracic spine by trained manual therapists for patients with non-specific mechanical

Figure 3 Between-group comparison for means scores on the numerical pain rating scale (NPRS) at baseline, second visit, and discharge. Error bars represent the 95% confidence interval for each mean score. No time point was statistically significant between-groups.

neck pain. The results, however, did show significant within session changes from the initial evaluation to discharge for both groups combined. The mean percent change on the NDI was 39% (± 12.2), which reflects a clinically meaningful change.³⁰ The patients in our cohort doubled the MDC of the PSFS with a change score of four points.³⁵ Patients in our study reported a reduction on the NPRS of 3.9 points (± 1.4) demonstrating a clinically important change.^{32,34} The mean change of hold time for the DCF endurance test was 22.05 seconds (± 12.8) for both groups. Fifteen of the 20 patients achieved normal hold times for the test according to Domenech *et al.*⁴² who found the average time for men and women was 38.9 ± 20.1 and 29.4 ± 13.7 seconds, respectively, in healthy adults. Finally, Stratford *et al.*³⁷ reported a change score of 5 on the GROC is clinically meaningful and our patients reported a mean change score of 5.5 (± 1.1). Finally, the types of AE reported in our study are consistent with other trials.^{10,19}

The within-group changes may be explained by the natural course of neck pain and the proposed clinical benefits of MT. Manual therapy propagates biome-

Table 2 Between-group results at second visit and discharge (N=20)

Variable	Mobilization group (N=13) mean (SD)		HVLA group (N=7) mean (SD)		P-value	
	Second visit	D/C	Second visit	D/C	Second visit	D/C
NDI (%)	25.8 (± 12.7)	14.6 (± 11.2)	20.5 (± 11.2)	12.6 (± 11.2)	0.34	0.33
PSFS score	5.8 (± 2.0)	8.0 (± 1.3)	6.3 (± 2.1)	8.6 (± 1.3)	0.69	0.20
NPRS	4 (± 2.8)	2.0 (± 1.73)	3.4 (± 2.8)	1.1 (± 1.1)	0.80	0.26
CAROM (degree)	47.3 (± 23.7)	54.2 (± 18.7)	41.5 (± 28.0)	57.2 (± 19.7)	0.69	0.18
DCF (second)	28 (± 17.9)	40.8 (± 11.1)	21 (± 18.9)	30.9 (± 12.1)	0.32	0.06
GROC	3 (± 2.1)	5.1 (± 1.5)	4.3 (± 2.3)	6.3 ($\pm .76$)	0.18	0.94
No. days from baseline		42.9 (20.9)		41 (20.6)		0.93
Visits		6.9 (± 2.2)		7.1 (± 4.6)		0.66

NDI: neck disability index; PSFS: patient-specific functional scale score; NPRS: numerical pain rating scale; CAROM: cervical active range of motion; DCF: deep cervical flexion; GROC: global rating of change; D/C: discharge.

95% Confidence interval for mean (standard deviation) of each outcome variable between-group results at discharge. ($P \leq 0.05$) analyzed with Mann-Whitney *U* test.

chanical changes that reduce tissue resistance, which leads to increase in range of motion.⁴³ The neurophysiological effects of MT influence various levels of the nervous system including the peripheral,^{44–46} spinal cord,^{47,48} and supraspinal level,^{49,50} in order to facilitate pain reduction⁸ and alter muscle tone.⁴⁹ In addition, our patients received a standardized HEP intended to maintain the range motion gains gathered by the MT and to improve the motor performance of the deep cervical flexors. A multimodal treatment approach that includes both MT and therapeutic exercise provides clinically superior results compared to MT alone.⁴ Deep cervical flexion exercises were chosen because patients with neck pain demonstrate reduced activity of the deep cervical flexors^{51,52} and training of these muscles is associated with neck pain reduction.⁵³

The investigators were permitted to change treatment to include the opposing intervention after the second visit. Therefore, interventions provided after the second treatment could have had an effect on outcomes at the time of discharge. This was allowed to simulate clinical practice by providing the clinicians with flexibility with their treatment. Of the 20 patients analyzed, 4 patients (2 from each group) received interventions from the opposing group after visit 2. Examples of additional treatments added after visit 2 included modalities, soft tissue mobilization, and scapular stabilization exercises.

The results from this study were consistent with the findings reported by both pragmatic studies done by Leaver *et al.*¹⁹ and Hurwitz *et al.*²¹ Leaver *et al.*¹⁹ analyzed the between-group differences between cervical mobilizations and manipulation for patients with recent neck pain (<3 months) who were suitable for cervical manipulation. The authors concluded that there were no significant differences in pain, disability, function, physical health, mental health, or global perceived effect between treatment groups at 2, 4, or 12 weeks.¹⁹ Hurwitz *et al.*²¹ also reported no significant differences in pain or disability between the patients who received cervical mobilization or manipulation, with or without a heat modality. Disability was measured using the NDI and the data were analyzed at 6 months.²¹ The treating investigators in their study did not provide thoracic spine treatment as we did, but our results were similar.

Our findings differed from those trials using prescriptive treatment for their mobilization groups.^{18,20} The conflicting results may be partially explained by the differences in treatment methods; however, other methodological differences including sample size and statistical analyses used renders specific conclusions speculative. First, Dunning *et al.*¹⁸ used a standardized mobilization performed bilaterally to C1–C2 regardless of symptom provocation. In the present study, inves-

tigators determined the dosage parameters of the specific technique and applied them to the most symptomatic level of the cervical spine and the level of segmental restriction in the thoracic spine, in order to obtain a desired change in the patient's condition. It is possible that differences in treatment dosage and level provided might alter effect on outcomes. Techniques aimed at biomechanical restriction or reproducing the patient's chief complaint may reduce neck pain more effectively than random techniques.²⁵ However, this requires further investigation. Finally, Dunning *et al.*¹⁸ examined the short-term (48 hours) difference in treatment techniques whereas the present study examined outcomes at several time points.

Cassidy *et al.*²⁰ reported that patients who received cervical manipulation had significantly higher reduction of perceived pain than the mobilization group but no significant differences in range of motion changes. They employed a muscle energy technique of four repetitions of 5-second holds. This mobilization procedure was different from the mobilizations provided in the present study. The authors collected outcomes immediately following the treatment so they lacked the longer-term follow-up at discharge collected in the present study.²⁰

Limitations

There were several limitations to this study. The sample size in this preliminary study was small and the distribution curves were not normal; therefore, the more conservative non-parametric statistics may obfuscate between-group differences that may exist. Within-group changes observed suggest that both treatments may have promising effects. Without a true control group, however, it is difficult to ascertain whether the within-group changes occurred as a result of the natural progression of the pathology. The lack of standard treatment procedures may challenge the internal validity of this study; however, this purposeful procedure to provide clinicians flexibility with their treatment was employed in order to replicate routine clinical practice. Potentially confounding the results was the compliance with HEP, which we did not monitor. We included patients with current neck pain of any duration. It is possible that patients of differing stages (acute or chronic) may respond differently to the interventions provided. Additionally, allowing clinicians to add or alter treatments after the second visit limits the ability to draw conclusion between the two treatment arms at discharge.

Conclusion

The results of this RCT demonstrate that there was no difference in clinical outcomes between mobilization and manipulation to the cervical and thoracic spines on mechanical neck pain. Both treatment

groups demonstrated clinically significant changes in pain, range of motion, and disability from initial evaluation to discharge. However, these results should be interpreted with caution because of the small sample size. The larger follow-up study to this preliminary trial should include a larger sample size and include more clinical sites encompassing a larger geographical area to improve the generalizability.

Disclaimer Statements

Contributors David Griswold designed the study, obtained IRB approval, subject recruitment, data collection, analyzed the data, wrote the manuscript, constructed all tables and figures, and submitted the manuscript. Ken Learman provided assistance in the planning process of the study, assisted with data collection, and reviewed/contributed to revisions of the manuscript. Josh Cleland served as the advisor to Griswold and provided assistance with the planning for the study, contributed by making revisions and providing input on the write-up as well as the tables and figures. Bryan O'Halloran reviewed and made contribution to the study protocol, performed as a data collector, and contributed to the write up during manuscript preparation.

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