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The Effects of Cervical Spine Mobilization versus Manipulation on Pain, Disability, and Satisfaction in Subjects with Non-specific Mechanical Neck Pain

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Background: Several studies have found an association between cervical spinal mobilizations (CSMob) and cervical spinal manipulations (CSM) on pain perception, disability, and satisfaction. However, choosing the proper technique continues to be a challenge for many practitioners.

Objectives: To study the effects of a single session of cervical spinal mobilization versus cervical spinal manipulation on pain, disability, and satisfaction.

Design: Randomized clinical trial.

Methods: 36 subjects with acute and non-specific mechanical neck pain were randomly assigned to one of 3 groups (CSMob, CSM, or control). Outcome measures using the Neck Disability Index (NDI), Numeric Pain Rate Scale (NPRS), and Global Rate of Change (GROC) were quantified at baseline, 5-minutes post, and 4 days post corresponding intervention.

Results: The CSM group showed significant increase in GROC ($p = 0.025$) compared to the CSMob and control groups ($p = 0.472$ and $p = 0.176$ respectively) over time. There was a significant decrease in NPRS for the CSM and CSMob groups ($p = 0.002$ and $p = < 0.001$) and a non-significant decrease in NPRS ($p = 0.642$) in the control group over time. Similarly, there was a significant decrease in NDI for the CSM and CSMob groups ($p = < 0.001$ and $p = < 0.001$) and a non-significant decrease in NDI ($p = 0.084$) in the control group over time.

Conclusion: Our study findings suggest that skilled manual therapy interventions can be a viable and effective treatment option for reducing neck pain, disability, and perceived favorable change following a single session on subjects with acute, non-specific mechanical neck pain.

Key Words: Disability, Pain, Spinal manipulation, Spinal mobilization

Introduction

Pain is the leading cause of disability in the United States and the world [1]. Specifically, neck pain is the fourth leading cause of disability in the general population, with 50% of individuals reporting that they have experienced neck pain at some point in their lives [1-3]. This prevalence is more common among women aged 35-49, in high-income countries, in urban settings, and is anticipated to increase substantially in the near future [3, 4]. Several studies have evaluated the cost-effectiveness of therapeutic manual interventions for neck pain and have determined that clinical research should emphasize the discovery and development of effective treatments for acute neck pain to prevent patients from succumbing to chronic pain and disability [4, 5].

Cervical spinal mobilizations (CSMobs) and cervical

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spinal manipulations (CSMs) are manual techniques performed by physical therapists and other healthcare providers to alleviate neck, low back, and musculoskeletal pain [1, 6-11]. Moreover, research suggests that patient expectations and psychological factors, in conjunction with physiological mechanisms, may influence the effectiveness of manual therapy treatments [12].

CSMobs incorporate manual forces with oscillatory movements transferred to the spine (non-thrust) [11, 13]. CSMobs involve passive movements including force magnitude, force amplitude, line of force application, oscillation frequency, and displacement [7, 11]. CSMs also involve a skilled manual application of high-velocity, low-amplitude forces (thrust) to the spine to impart neurophysiological, mechanical, and biochemical effects which result in improved function of the joints, muscles, and nerves [10, 14-19].

Multiple mechanical-based proponents emphasize that the application of a mechanical force, whether thrust or non-thrust, triggers a neurophysiological response, including an autonomic (ANS), peripheral (SNS), and endocrine system (HPA-Axis) response [16-22]. Some studies have further examined the effectiveness of different mobilization forces, and it has been observed that a higher mobilization force leads to a greater reduction in pain than a lower force [11, 20].

Moreover, systematic reviews have provided moderate evidence indicating the efficacy of manual therapy in the treatment of spinal pain (e.g., neck pain, headaches, low back, etc.) in combination with exercises [7, 11, 23-25]. However, the neurophysiological mechanisms by which CSMs and CSMobs provide pain relief continue to be elusive [19, 26]. Previous research reveals inconsistent evidence for differences between CSM and CSMob in terms of treatment satisfaction, pain relief, and disability reduction [27].

The purpose of this study was to clarify the discrepant evidence regarding the efficacy of a CSMob versus a CSM intervention as compared to a control group – hands-off, and patient education (PE) in isolation. We hypothesized that a single application of CSMob or CSM may significantly improve pain, disability, and satisfaction in participants with acute, non-specific mechanical neck pain compared to a PE only group.

Methods

Study Design

A single-blinded, randomized controlled clinical trial was conducted to evaluate the effects of CSM and CSMob on neck pain, disability, and patient satisfaction. Participants were randomly assigned to one of three groups: CSM, CSMob, or PE. Data was taken at baseline prior to any intervention, shortly after the intervention, and four days later (Figure 1).

Participants

A total of 36 subjects were eligible for this study over a period of 9 months (from November 2021 to August 2022). Flyers, emails, and clinicaltrials.gov were the primary methods of recruitment (Figure 1). Eligible subjects required to be between 18 and 60 years of age, have experienced mechanical neck pain for less than 30 days, have negative upper cervical instability tests, and have a basal Neck Disability Index (NDI) score of equal or greater than 10/50. Due to the anatomical complexity of the cervical spine, participants were disqualified from the study if they had any of the following conditions: cervical arterial dysfunction (nystagmus, gait disturbances, Horner syndrome, positive extension-rotation test, serious medical conditions (i.e., cancer), history of cervical spine surgery, onset of neck pain from a traumatic incident, history of whiplash, history of spinal cord injury, spinal fractures, the presence of at least two positive neurological indicators, which are indicative of nerve root compression (i.e., alterations in sensation, myotomal attenuation, or diminished deep tendon reflexes), neurological conditions involving the central nervous system, osteoporosis, osteopenia, rheumatoid arthritis, ankylosing spondylitis, and autoimmune diseases.

Randomization

Subjects were randomly assigned using computer-generated numbers and were allocated by the primary

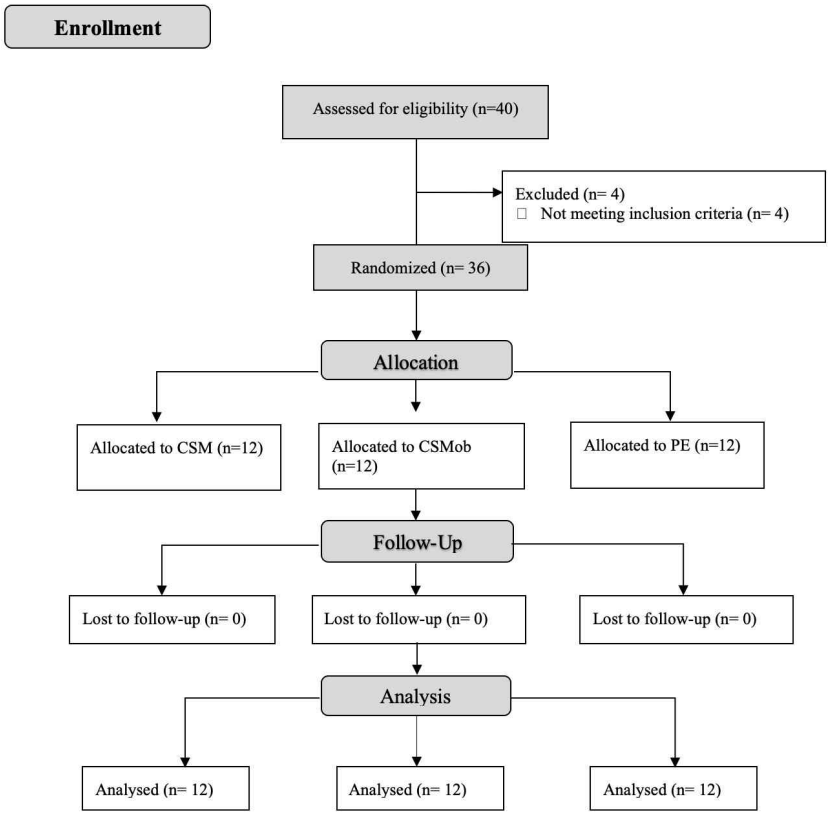


Figure 1. Flowchart of participant selection

investigator to one of the following three groups: CSM, CSMob, or PE. Subjects were blinded for the group assignment. The Institutional Review Board (IRB) of Loma Linda University granted approval for the study protocol and was registered with a clinical trial registry (ClinicalTrials.gov) (NCT04911608) prior to enrollment.

Procedures

All participants completed and signed an Informed Consent form and Authorization to Use of Protected Health Information (PHI) for research in compliance with the ethical principles outlined in the Declaration of Helsinki (1975, revised 1983). Subjects were assessed for cervical movement impairments, special tests to rule out neck pain with radiating pain, which was an exclusion criteria for this study (i.e., Spurling's Test, Distraction Test), and two safety tests to rule out upper cervical instability (i.e., Alar Ligament Test, Transverse Ligament Test). Passive accessory intervertebral mobility (PAIVM) testing of the cervical spine was performed to determine symptomatic and/or stiff segment(s). Subjects then completed questionnaires to assess pain, satisfaction, and disability levels at baseline, shortly after the intervention, and four days post-intervention. The following outcome questionnaires were used: The Global Ratings of Change (GROC), the Numeric Pain Related Scale (NPRS), and the Neck Disability Index (NDI).

Interventions

Cervical Spinal Manipulation

The CSM comprised of one session of a manual technique administered by a single healthcare practitioner with a doctorate in physical therapy with >12 years of clinical experience in an outpatient orthopaedic practice plus advanced training in spinal manipulation by completing hands-on modules under direct supervision of Gibbons and Tehan. The technique employed falls under the category of

Figure 2. Cervical Manipulation Technique

Figure 3. Cervical Mobilization Technique

high-velocity, mid-range, low-amplitude forces, as delineated by Gibbons and Tehan [28], with either left side bending and right rotation or right side bending with left rotation targeted and the painful and/or restricted segment. This manual therapy technique is referred to as a "Minimal Leverage Thrust," which is designed to provide patients with the utmost comfort during treatment, thereby minimizing post-treatment discomfort and pain. The participant was placed in supine with the cervical spine in neutral alignment. The practitioner then used clinical reasoning to identify and select the most suitable symptomatic or restricted cervical segment for the application of the CSM and CSMob. The physical therapist's middle phalanx was placed in direct contact with the posterolateral aspect of the indicated segment while the opposite hand created a chin-hold technique. A high-velocity, low-amplitude force (thrust) was applied upward and forward, parallel to the zygapophysial joint plane of movement towards the painful/restricted side and then towards the opposite side (Figure 2). One of the primary goals for this kind of spinal manipulation is to achieve cavitation which typically follows a “popping” or “cracking” sound. This is generated by a drop in the internal pressure of the synovial joint due to tribonucleation [28-32]. If no cavitation was attained during the first time, a second attempt was performed in order to reach cavitation. The CSM was performed bilaterally on the same segment. All manual therapy procedures in this study adhered to the safety guidelines outlined for safe orthopaedic manual therapy practice [33].

Cervical Spinal Mobilization

The CSMob intervention comprised of 60-seconds of preparatory of low force (approximately 30N or 7 lbs) mobilizations (Grade II), then 60-seconds of high force (approximately 90N or 20 lbs) mobilizations (Grade III) concluding with 60-seconds of low force (approximately 30N or 7 lbs) mobilizations (Grade II). Both forces utilized large amplitude oscillatory movement, the low force began with the practitioner’s thumbs resting on the spinous process, whereas the high-force technique began at the zygapophyseal joint mid-range in a prone position (Figure 3) [13]. The joint mobilization standard oscillation frequency was set at 1.0 Hz for both force applications. [8, 11]. These protocol modifications are compatible to the existing body of cervical spine knowledge regarding force, dosage, and location [8, 11]. The addition of the low force level of 30N to our protocol was based on the need to achieve a balance between two important factors: the ability to induce a change in stiffness within the cervical spine and the need for a clear and discernible contrast with a high force level of 90N. This approach ensures that the study findings would build on existing evidence and can be used to further advance our understanding of the best scientific approaches for pain modulation in individuals with neck pain [11, 34].

Postural Education Group

For the PE (no touch) group, subjects were shown a standardized educational short video (6 min) of

postural correction movement during activities of daily living [35]. Despite education being recognized as an active experimental intervention in the Neck Pain 2017 - Revision Clinical Practice Guidelines (CPG) [25] and receiving an A Grade in Neck Pain CPG 2008 [23], it is not recommended to offer education as a standalone intervention. Therefore, this study considered PE as a control intervention (free of intervention).

Outcome Measures

Global Ratio of Change

The Global Ratio of Change (GROC) score is a 15-point recall-based questionnaire commonly used to assess the effectiveness of a series of care episodes. The development of this scale aimed to quantify the improvement or deterioration of a patient's condition over time, typically to assess the effectiveness of an intervention or track the clinical progression of a condition [36, 37]. The scale ranges from +7 (a very great deal better) to 0 (about the same) to -7 (a very great deal worse). Scores of +4 and +5 have traditionally been associated with moderate improvements in patient status, while scores of +3, +4, and +5 have been utilized to differentiate between improved and stable patients [38]. By limiting the recall period, we hoped to minimize recall decay and fluctuations in temporal stability. We set a predetermined GROC score for success in assessing subject satisfaction or perceived improvement as a single cut-score of 3+ or "somewhat better" [39]. Our results suggest that the GROC score may be a more reliable tool for evaluating short-term outcomes, as subjects' maximal recall was limited to four days, thus avoiding previously reported issues with longer recall periods.

Numeric Pain Rating Scale

The Numeric Pain Rating Scale (NPRS) has proven to be a dependable and valid self-report tool for patients experiencing neck pain, regardless of the presence of radiculopathy [23, 38]. This survey instrument uses an 11-point scale to gauge the patient's pain level, with values ranging from 0 (absence of pain) to 10 (most extreme pain conceivable). The NPRS has been shown to possess a high level of accuracy in identifying primary care patients who experience clinically significant pain, making it an effective screening tool [38]. Furthermore, the reliability of the NPRS (ICC) in individuals with neck pain has been reported to be 0.76 as reported [38]. The Minimum Clinically Important Difference (MCID) is a concept used in healthcare to describe the least change in a patient's condition that is considered meaningful or significant from the patient's perspective. In the context of the NPRS, the MCID represents the smallest change in the NPRS that is considered clinically meaningful. The MCID range is 1.3 to 4.5 [23, 38] and minimal detectable change (MDC) varies between 2.1 and 4.3 meaning that any change in the score that falls within this range could be attributed to measurement error rather than reflecting a genuine change in the patient's health status. Two studies recommended that clinicians and researchers should anticipate a minimum reduction of 2.5 points in the NPRS and 5.5 points in the NDI after 4 weeks of intervention, as these changes are considered clinically significant [38]. Since our study was a one-time intervention rather than an entire episode of care (e.g., 4-weeks of intervention), we set our cut score for clinical importance at a 2/10 pain level as recommended by others, including another one-day intervention comparing non-thrust to thrust thoracic mobilization/manipulation [40, 41].

Neck Disability Index

The Neck Disability Index (NDI) is widely regarded as the most commonly utilized measure of self-reported disability among individuals experiencing neck pain [38]. This tool has been employed in about 300 publications, with multiple studies indicating that the NDI score was the best predictor for outcome. A high initial NDI recovery predicts chronicity while a low initial NDI forecasts recovery [42, 43]. The evaluation of each functional component is assessed on a scale of 0 to 5, with a maximum possible score of 50 points, where 0 signifies no disability and 5 indicates complete disability [38]. As the score increases, the level of disability also increases. Vernon et al. [42, 43] reported test-retest correlations ranging from 0.90 to 0.93, indicating good reliability of the

NDI. According to Young et al. [38], their findings exhibited impressive reliability (ICC) measurements at all examined intervals (1 week = 0.94, ($p < 0.001$). Moreover, the MCID margin for NDI is 5, or 10%, which suggests that a change in NDI score of 5 points or more or a change of 10% or more from the baseline score is considered clinically significant.

Power Calculations

According to the repeated measures mixed design of the present investigation, a power analysis was conducted utilizing G*Power (Version 3.1.9.2; Heinrich-Heine Universität, Düsseldorf, Germany). To achieve 80% power at a 5% significance level for an effect size of 0.25 to 0.30, a minimum sample size of n = 36 was necessary [16, 19].

Statistical Analysis

Mean ±SD was calculated for quantitative variables and frequency (percentage) for ordinal variables. The normality of quantitative variables was evaluated through the application of the Shapiro-Wilk test and the creation of box plots. Kruskal Wallis Test was used for all continuous and independent variables in three groups at baseline due to the limited sample size and the absence of normality in some variables. An independent Chi-square test was employed to test the difference between intervention and PE groups by categorical variables at baseline. A repeated-measures analysis of variance (RM-ANOVA) was conducted to analyze the influence of the between-group factor (CSM, CSMob, or PE) and within-group factor (time) on the dependent variables (GROC, NPRS, and NDI) [44]. The significance level was set at $p < .05$. Management and data analysis were performed using SPSS Statistics Software version 28.0 (SPSS Inc., Chicago, IL, USA).

Results

36 subjects satisfied the eligibility criteria and agreed to participate in the study after being screened from a total of 40 participants. The individuals were divided randomly into three groups (n = 12) using computer-generated numbers (Figure 1). The average age and weight of the CSMob group were lower than the other two groups. In addition, NDI was lower in the CSM group. However, there was no statistical significance between three groups at baseline. As anticipated with the randomized design, none of the demographic variables exhibited statistical significance ($p > .05$) (Table 1).

Patient Satisfaction

There was a significant increase in the GROC for the CSM group from after 5 minutes to 4 days ($p = 0.025$) and a non-significant increase for the CSMob and PE groups ($p = 0.472$ and $p = 0.176$, respectively) over time (Table 2 & Figure 4). However, there was no significant difference between groups (F = 1.015, $p = 0.374$, Partial Eta Squared = 0.061) (Table 2). It is important to note that the GROC questionnaire demonstrates changes in satisfaction only after the intervention. Thus, the questionnaire was completed shortly after the intervention and 4-days post-intervention and there was no baseline measure.

Pain

There was a significant decrease in the NPRS for the CSM and CSMob groups ($p = 0.002$ and $p < 0.001$, respectively) and a non-significant decrease in the PE group ($p = 0.642$) over time (Table 2 & Figure 4). However, there was no significant difference between groups (F = 0.178, $p = 0.838$, Partial Eta Squared = 0.011) (Table 2).

Disability

Similarly, there was a significant decrease in NDI for the CSM and CSMob groups ($p = < 0.001$ and $p = < 0.001$, respectively) and a non-significant decrease in NDI in the PE group ($p = 0.084$) over time (Table 2 & Figure 4). Also, there was no significant difference between the groups (F = 0.943, $p = 0.400$, Partial Eta Squared = 0.054). It is important to note that the NDI involves changes in disabilities during certain activities of daily living. Therefore, the questionnaire was completed at baseline and four days post-intervention.

Table 1. Characteristics of participants at baseline

Characteristics	**CSM (n＝12)**	**CSMob(n＝12)**	**PE (n＝12)**	***p* − value**
	Mean±SD	**Mean±SD**	**Mean±SD**	***p* − value[a]**
Age	34.3±12.4	28.7±8.5	32.9±11.23	0.229
Height (inch)	65.8±4.0	64.5±3.29	65.3±2.8	0.468
Weight (lbs)	186.0±62.31	153.00±25.1	180.17±53.8	0.194
GROC	12.42±1.97	11.18±2.82	11.17±2.55	0.419
NPRS	2.83±1.53	3.33±2.19	2.17±0.94	0.498
NDI	12.42±1.97	17.67±11.11	17.67±9.49	0.355
	Frequency (%)	**Frequency (%)**	**Frequency (%)**	***p* − value[b]**
Gender				0.641
Female	8(66.7)	9(75.0)	10(83.3)	
Male	4(33.3)	3(25.0)	2(16.7)	
Time of Last Medication				0.491
＜24 hours	0(0.0)	1(8.3)	2(16.7)	
＞24 hours	10(83.3)	7(58.3)	7(58.3)	
Not currently taking	2(16.7)	4(33.3)	3(25.0)	
Last Exercise				0.191
＜24 hours	5(41.7)	1(8.3)	4(33.3)	
＞24 hours	7(58.3)	10(83.3)	7(58.3)	

Abbreviation: GROC, Global Ratings of Change; NPRS, Numeric Pain Rating Scale; NDI, Neck Disability Index. Lbs ＝pounds

[a] Kruskal Wallis Test

[b] Chi-square test

Table 2. Within/Between Group Comparison of Pain, Disability, and Satisfaction

Group	**Time**	**GROC**	**NPRS**	**NDI**
CSM	P-Value[a]	0.025	0.002	＜.001
	Baseline	N/A	2.83(1.52)	13.33(6.05)
	After 5 Mins	12.42(1.97)	1.75(2.14)	N/A
	After 4 Days	13.08(1.88)	1.17(1.47)	6.67(7.00)
CSMob	P-Value[a]	0.472	＜.001	＜.001
	Baseline	N/A	3.45(2.25)	17.67(11.11)
	After 5 Mins	11.18(2.82)	2.00(1.73)	N/A
	After 4 Days	11.64(3.20)	1.27(1.35)	8.00(11.18)
PE	P-Value[a]	0.176	0.642	0.084
	Baseline	N/A	2.17(0.94)	17.67(9.49)
	After 5 Mins	11.17(2.552)	2.08(0.90)	N/A
	After 4 Days	12.08(3.00)	2.33(1.83)	11.17(7.65)
	P-Value[b]	0.374	0.838	0.400

Abbreviation: GROC, Global Ratings of Change; NPRS, Numeric Pain Rating Scale; NDI, Neck Disability Index; CSM, Cervical Spinal Manipulation; CSMob, Cervical Spinal Mobilization; Postural Education, PE.

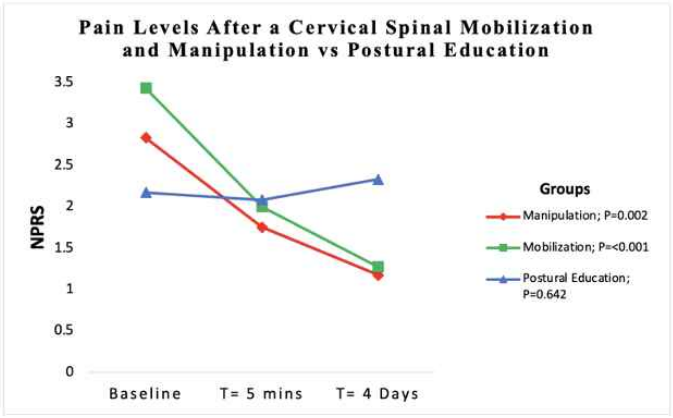
[a] p- values for the null hypothesis that there is no difference between pre and post.

[b] p- values for the null hypothesis that there is no difference between groups.

[1]F＝1.015and Partial Eta Squared＝0.061

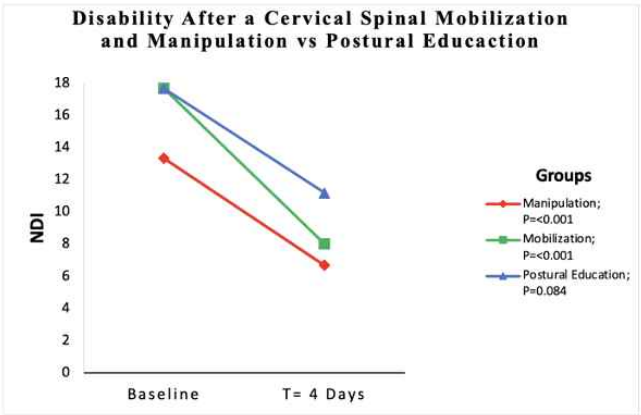
[2]F＝0.178 and Partial Eta Squared＝0.011

[3]F＝0.943and Partial Eta Squared＝0.054



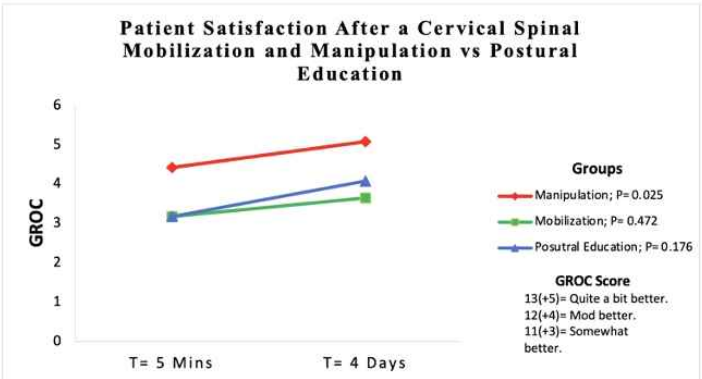
Abbreviation: GROC, Global Ratings of Change; NPRS, Numeric Pain Rating Scale; NDI, Neck Disability Index

Figure 4a. Pain Levels After a Cervical Mobilization and Manipulation vs Postural Education



Abbreviation: GROC, Global Ratings of Change; NPRS, Numeric Pain Rating Scale; NDI, Neck Disability Index

Figure 4b. Disability After a Cervical Mobilization and Manipulation vs Postural Education



Abbreviation: GROC, Global Ratings of Change; NPRS, Numeric Pain Rating Scale; NDI, Neck Disability Index

Figure 4c. Patient Satisfaction After a Cervical Mobilization and Manipulation vs Postural Education

Discussion

The main purpose of this research was to examine the immediate and limited-duration impact of CSM and CSMob compared to a PE group. The findings of this study suggest that CSM and CSMob may be more effective in immediately reducing neck pain, as indicated by the changes in numeric pain rating scores over time. Moreover, CSMob demonstrated pain reduction at Day 4 compared to the CSM group (Table 2, Figure 4). Conversely, the PE group did not show any significant improvement in pain rating. Both the CSM and CSMob groups showed pain improvements in excess of the MCID threshold of 1.3 with a single treatment. It is worth mentioning that the absence of any significant pain relief in the PE group implies that changes seen in the CSM and CSMob groups may be due to the interventions themselves rather than the natural course of pain improvement over time. Several proposed biomechanical neuro-physiological, and more recently biochemical models suggest that the application of a mechanical force initiates a cascade of responses in the body that involves activation of the autonomic nervous system (ANS), sympathetic nervous system (SNS), and hypothalamic-pituitary-adrenal (HPA) axis thus stimulating the release and inhibition of multiple biomarkers affecting nerve pathways including pain reduction [12, 16-18, 21, 22, 45]. Nonetheless, it is essential to highlight that this study supports the vast evidence suggesting that a manually induced force, whether thrust (CSM) or non-thrust (CSMob), is needed in order to "ignite" the neurophysiological and bio-chemical response for neck pain reduction and improvement in disability.

Our findings in the CSMob group differed from those of Snodgrass et al. [11], who reported a slight increase in pain following 3-bouts of 60-seconds (3-minutes total) of high force (90N) mobilizations. In our study, the CSMob group received a treatment that consisted of 60-seconds of preparatory low force (approximately 30N or 7 lbs) mobilizations (Grade II), then 60-seconds of high force (approximately 90N or 20 lbs) mobilizations (Grade III) concluding with 60-seconds of low force (approximately 30N or 7 lbs) mobilizations (Grade II). It is worth emphasizing that our subjects had a significant reduction in pain shortly after 3-minutes of central posteroanterior CSMob. We theorize that this difference may be due to the combination of both low- and high-force spinal mobilizations. Our findings suggest that combined joint mobilization forces (low and high force) could have obtained favorable immediate pain reduction with the application of a low force and short-term pain modulation benefits of a high force application.

Regarding disability, all three groups met our a priori criteria for change in disablement [38]. There were significant improvements in the NDI score in both the CSMob and CSM groups, but not in the PE group.

In terms of satisfaction, all three groups met our minimal cut score of +3 or "somewhat better" shortly after the respective interventions. On Day 4, the CSM group reported feeling "quite a bit better" while the CSMob group reported feeling "moderately better." However, only the CSM group showed statistically significant improvements in satisfaction over time. Interestingly, cavitation was achieved in 11 of 12 participants. Even though cavitation is one of the primary objectives when delivering a CSM, further research should be conducted on the relationships between an audible "pop" or "crack" and subject's satisfaction after the intervention.

When addressing neck pain impairment in patients, healthcare providers may find the findings in this study beneficial, as they may assist in the proper treatment selection. Both manual techniques showed greater than MCID pain improvements following one treatment, and both groups showed significant improvements in disability over the 4-day follow-up period. However, only the CSM group participants reported improved satisfaction on Day 4.

Clinically, certain patients may present with a contraindication for CSM, while others may be apprehensive or reluctant to undergo a CSM technique due to multiple preconceived reasons. In addition, not all physical therapists may feel confident in performing CSMs due to concerns about their proficiency in the procedure, the potential for adverse events, or a lack of clinical experience. As a result of this study's findings, clinicians now have another potential option for pain modulation to consider when CSM is not

suitable. Overall, these results provide compelling evidence to suggest that CSMs and CSMobs can be effective treatments for reducing pain and disability. Nevertheless, it is essential to carefully consider each patient's unique circumstances and preferences before deciding the most appropriate course of treatment.

Limitations

Subjects in this study had non-specific mechanical neck pain and were classified as Neck Pain with Mobility Deficits following the criteria outlined in the International Classifications of Functioning, Disability, and Health (ICF) from the Orthopaedics Section of the American Physical Therapy Association (APTA) [25]. Subjects classified with neck pain and experienced difficulty coordinating movements (including those with an acute traumatic neck conditions and whiplash-associated disorders) and those with radiating pain from the neck were not included in the study [25]. Therefore, the findings of this study may not be generalizable to other neck pain classifications. Additionally, subjects in all three groups presented with low tissue reactivity, low pain levels (3/10 or less), and moderate to mild disability. This may have created a potential floor effect and limited generalizability to individuals with moderate-to-high tissue reactivity.

Additional study limitations may include the fact that our findings are restricted to the immediate and limited-duration impact of a single CSM or CSMob on a defined sample of subjects with acute, non-specific neck pain therefore limiting the number of subjects within a time frame required to perform this study. Finally, we considered PE as a control group. Although education should not be administered in isolation, it is still a recommended treatment [23, 25]. For this reason, we may have had three intervention groups rather than a control group. Nevertheless, the two skilled manual therapy interventions demonstrated significant pain reduction and satisfaction as compared to the PE group, which may help explain why all three groups with acute pain had a reduction in disability after 4 days with a single treatment session.

Suggestions for future studies: To deepen our understanding of the neurophysiological effects associated with pain reduction, investigations into the optimal combination force magnitudes could help elucidate the most effective way to achieve pain reduction in individuals with neck pain. Although the current study applied manual therapy specifically to the symptomatic segment, there is potential for future research to explore the effects of applying low- and high-force combinations on segments located at a distance from the symptomatic region.

Conclusion

In conclusion, our study aimed to investigate the immediate and limited-duration effects of CSM and CSMob on neck pain, disability, and satisfaction compared to Hands-Off Postural Education group. Our results showed that CSM and CSMob may be effective in reducing neck pain over time. Both the CSM and CSMob groups reported improvements in satisfaction on day four, with the CSM group showing the highest favorable perceived change. The finding that these improvements were not also observed in the PE group suggests that manual therapy confers benefits beyond only time effects which supports previous findings [46, 47]. It is important not to undermine the importance of a patient-centered approach which ensures that treatments are customized to individual needs therefore optimizing patient satisfaction and outcomes. With this in mind, clinicians must also consider other important factors when choosing a CSM over a CSMob technique such as outlined contraindications and patient’s preconceived fears about pain, potential adverse effects, or negative past experiences. Moreover, not all clinicians may feel confident in performing a CSM and the concerns they may have about their proficiency in the technique, the potential for adverse events, such as vertebral artery dissection, or the lack of clinical experience can hinder their willingness from using CSM. It is essential that healthcare providers, including physical therapists, are adequately trained and have proper experience in order to be confident when choosing this manual technique. But more importantly, the findings of this study offer clinicians an alternative manual technique for pain modulation when CSM is not suitable. This provides a

broader range of treatment options that can help address the needs of patients who cannot or do not wish to undergo a CSM. Our investigation adds to the body of evidence that CSM and CSMob are effective at reducing neck pain, disability, and perceived a favorable change following a single session.

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