JOURNAL OF MANUAL & MANIPULATIVE THERAPY
2021, VOL. 29, NO. 5, 267–275
https://doi.org/10.1080/10669817.2020.1834322

Taylor & Francis
Taylor & Francis Group

Pragmatic application of manipulation versus mobilization to the upper segments of the cervical spine plus exercise for treatment of cervicogenic headache: a randomized clinical trial

Addison Lerner-Lentz[a], Bryan O'Halloran[b], Megan Donaldson[c] and Joshua A. Cleland[d]

[a]Clinician and Researcher for Pain Relief and Physical Therapy, Havertown, PA, USA; [b]Director of Physical Therapy for Pain Relief and Physical Therapy, Havertown, PA, USA; [c]Program Director for the Doctor of Physical Therapy Program, Tufts University School of Medicine, Boston Mass; [d]Director of Research and Faculty Development, Tufts University School of Medicine, Boston, Mass

ABSTRACT

Background: The effectiveness of manipulation versus mobilization for the management of spinal conditions, including cervicogenic headache, is conflicting. However, a pragmatic approach comparing manipulation to mobilization has not been examined in a patient population with cervicogenic headache.

Objectives: To evaluate the effectiveness of manipulation compared to mobilization applied in a pragmatic fashion for patients with cervicogenic headache.

Methods: Forty-five (26 females) patients with cervicogenic headache (mean age 47.8 ± SD 16.9 years) were randomly assigned to receive either pragmatically selected manipulation or mobilization. Outcomes were measured at baseline, the second visit, discharge, and 1-month follow-up and included the Neck Disability Index (NDI), Numeric Pain Rating Scale (NPRS), the Headache Impact Test (HIT-6), the Global Rating of Change (GRC), the Patient Acceptable Symptoms Scale (PASS). The primary aim (effects of treatment on disability and pain were examined with a mixed-model analysis of variance (ANOVA), with treatment group (manipulation versus mobilization) as the between subjects variable and time (baseline, 48 hours, discharge and follow-up) as the within subjects variable.

Results: The interaction for the mixed model ANOVA was not statistically significant for NDI ($p = 0.91$), NPRS ($p = 0.81$), or HIT ($p = 0.89$). There was no significant difference between groups for the GRC or PASS.

Discussion and Conclusion: The results suggest that manipulation has similar effects on disability, pain, GRC, and cervical range of motion as mobilization when applied in a pragmatic fashion for patients with cervicogenic headaches.

Clinicaltrials.gov: NCT03919630

KEYWORDS
Cervicogenic headache; manipulation; mobilization; pragmatic

Introduction

Headache disorders impact approximately 66% of the population and result in substantial pain, disability, lost work productivity, and costs to society[1].′ In fact, the World Health Organization has classified headaches as one of the top ten disabling conditions in the world [2]. One of the more common headache types, cervicogenic headache, is associated with neck pain and dysfuction[3]. It has been reported that cervicogenic headache has a prevalence in the general population ranging from approximately 0.4% to 20% [4–6], and is responsible for nearly one quarter of all reported chronic headaches [6].

Cervicogenic headaches typically arise from musculoskeletal components of the cervical spine, disc, or soft tissue elements and are accompanied by neck pain[7]. Dominant features of cervicogenic headache include unilateral head pain, external pressure over the ipsilateral upper neck, limited cervical range of motion, and reproduction of symptoms with various neck movements[7]. Cervicogenic headaches typically originate from the atlanto-occipital joint and upper three segments of the cervical spine which can cause radiating symptoms to the head or face region[8].

Recent clinical practice guidelines have suggested the use of manual therapy and exercise as the first treatment option for the management of individuals with cervicogenic headache, however no specific recommendations have been made regarding the type of manual therapy that is most effective[9]. Manual therapy refers to a number of joint-based techniques aimed at reducing pain and improving function[10]. The most commonly used forms of manual therapy for individuals with cervicogenic headache are manipulation and mobilization directed toward the joints of the upper cervical spine. Inconsistent terminology related to manual therapy may be partially attributable to the perception that

CONTACT Joshua A. Cleland joshcleland@comcast.net Director of Research and Faculty Development, Doctor of Physical Therapy Program, Department of Public Health and Community Medicine, School of Medicine, Tufts University
Supplemental data for this article can be accessed here

manipulation and mobilization are of equivalent clinical effectiveness. However, the manipulation versus mobilization directed toward upper cervical spine segments in individuals with cervicogenic headaches requires further scientific evaluation.

A recent study by Dunning and colleagues [11] examined the effects of upper cervical and upper thoracic manipulation versus mobilization in individuals with cervicogenic headache. Their results found that individuals receiving manipulation experienced significantly greater and more clinically meaningful improvement in pain and disability at 3-month follow-up than those receiving mobilization. However, the study design used by Dunning and colleagues [11] was prescriptive in nature (clinicians were told exactly what levels to treat and what techniques to use) which fails to account for therapists decision making and the patient's clinical presentation[12]. In comparison, pragmatic trials allow clinicians the ability to select techniques they feel most appropriate for the individual patient given their clinical presentation. This study design may be more generalizable to actual clinical practice than prescriptive trials[13].

It has recently been shown in individuals with low back pain that the use of a pragmatic or prescriptive approach to manual therapy results in similar outcomes. Donaldson et al. [14] found that individuals with low back pain experienced similar outcomes in pain and disability regardless of whether the manual technique was applied in a prescriptive (clinicians told exactly what to do) or pragmatic (clinicians could select the level and technique to use) treatment approach[14]. Roenz and colleagues [15] performed a systematic review and meta-analysis examining the impact of pragmatic versus prescriptive study designs on the outcomes of low back and neck pain when using manipulation or mobilization techniques. Their findings indicate a significant difference in favor of manipulation for reducing pain and disability when a prescriptive approach was used but these differences did not exist when a pragmatic approach to treatment was implemented. To date, only the Dunning et al. study[11], which used a prescriptive approach to treatment, has compared the effects of manipulation to mobilization for individuals with cervicogenic headache. We were unable to find any studies comparing the effects of manipulation to mobilization applied in a pragmatic fashion for the management of individuals with cervicogenic headache. Therefore, the purpose of this study was to examine the effects of mobilization versus manipulation and exercise on disability and pain in a patient population with cervicogenic headache using a pragmatic design.

Methods

The design for this study was a randomized pragmatic clinical trial.

Consecutive patients over a 12-month period (April 2019–April 2020) presenting to physical therapy at one of three outpatient clinics: Pain Relief and Physical Therapy, Havertown, PA, Professional Physical Therapy, Philadelphia, PA, and Holsman Physical Therapy, Clifton, NJ, with a primary report of headaches were screened for eligibility criteria. Inclusion criteria required patients to be between the ages of 18 and 65 years, with a primary report of headache. To be eligible to participate patients had to present with a diagnosis of cervicogenic headache defined as unilateral headache associated with neck pain and aggravated by neck postures or movement and joint tenderness in at least one of the three upper cervical joints (C0-C3) as assessed by manual palpation [3]. Additionally, patients had to report having at least two headaches in the last month, a Neck Disability Index (NDI) score of at least a 20% or greater and a pain intensity of at least 2/10 on the Numeric Pain Rating Scale (NPRS). Patients were excluded if they exhibited: medical red flags suggestive of a non-musculoskeletal etiology of symptoms, history of a whiplash injury within six weeks of the examination, a diagnosis of cervical spinal stenosis, evidence of any central nervous system involvement, or signs consistent with nerve root compression (at least two of the following had to be diminished to be considered nerve root involvement: myotomal strength, sensation or reflexes), exhibit any red flag symptoms of cervical instability tests, or who show signs of the '5 D's' (dizziness, drop attacks, dysarthria, dysphagia, diplopia) or patient who have signs of the three Ns (nystagmus, nausea, other neurological symptoms). All patients reviewed and signed a consent form approved by the Institutional Review Board at Franklin Pierce University, Manchester, NH prior to participation. This clinical trial was registered at clinicaltrials.gov (#NCT03919630) [2].

Therapists

Four physical therapists (mean age 45, SD 14.4) participated in the examination and treatment of all patients in this study. All therapists underwent a standardized training regimen prior to the start of the study. All participating therapists were Fellows in Training in an Orthopedic Manual Physical Therapy Program or were already established Fellows in Orthopedic Manual Physical Therapy and underwent training provided by the lead investigator. During this training session, all participating therapists were required to demonstrate the examination and treatment techniques to ensure that all study procedures were performed in a standardized fashion. To ensure fidelity to the study protocol the lead investigator contacted all therapists involved in patient recruitment and treatment on a bi-monthly basis.

Examination procedures

All patients provided demographic information and completed several self-report measures, followed by a standardized history and physical examination at baseline. The historical items include questions pertaining to the onset of symptoms and the distribution of symptoms. The physical examination items are those that are routinely used in the physical therapy examination of patients presenting with cervicogenic headache.

Self-report measures included the Neck Disability Index (NDI)[16], Headache Impact Test (HIT-6)[17], and the numeric pain rating scale (NPRS)[18].

Outcomes

The primary outcome measure used in this study was patient perceived level of disability as captured with the NDI at baseline, during the second visit, discharge and 1-month follow-up post discharge. The NDI has been demonstrated to be a reliable and valid outcome measure for individuals with cervicogenic headache [19]. Young and colleagues [19] identified the minimal detectable change (MDC) on the NDI as 5.5 points in individuals with cervicogenic headache. Similar to Young et al we reported the raw score on the NDI (0-50) [19]

Secondary outcome measures included pain intensity as measured by an 11-point NPRS. The scale is anchored on the left (score of '0') with the phrase 'No Pain' and on the right (score of '10') with the phrase 'Worst Imaginable Pain'. Numeric pain scales have been shown to be reliable and valid [18,20]. The MCID for the NPRS has been reported to be two points[21]. We also collected the impact of headaches on quality of life, social functioning, cognitive functioning and psychological distress using the Headache Impact Test (HIT-6) which is a six-item self-report, questionnaire[17]. The HIT-6 has been validated and found to have good internal consistency and good test-retest reliability. Measurements of active cervical range of motion (ACROM) including flexion and extension in the sagittal plane, lateral flexion in the frontal plane and rotation in the transverse plane were also collected at baseline, second visit and discharge. A single inclinometer and Cervical Range of Motion Device were used to collect ACROM[22].

At the time of the follow-up periods patients completed the GRC [23] and the Patient Acceptable Symptom State (PASS). Patients were asked to rate their overall perception of improvement since beginning treatment on the GRC scale ranging from − 7 (a very great deal worse) to zero (about the same) to +7 (a very great deal better)[23]. Patients also completed the PASS at each follow-up period which defines the level of symptoms beyond which patients consider themselves well [24] and are unlikely to seek further care[25]. The PASS question: 'Taking into account all the activities you have during your daily life, your level of pain, and also your functional impairment, do you consider that your current state is satisfactory?' with response options 'yes' or 'no'[24], with those who reported 'yes' categorized as a success.

Finally, at each subsequent visit and follow-up patients were queried about the presence of side effects. Participants were asked if they experienced any discomfort after the previous treatment and if so what type of discomfort did they experience and how long did it last.

Randomization

Following the baseline examination, patients were randomly assigned to receive mobilization or manipulation directed at the upper cervical spine plus exercise. Concealed allocation was performed by using a computer-generated randomized table of numbers created prior to the beginning of the study by an individual not involved with subject recruitment. Individual, sequentially numbered index cards with the random assignment were prepared. The index cards were folded and placed in sealed opaque envelopes. A second therapist who was blinded to the baseline examination findings opened the envelope and proceeded with treatment according to the group assignment. However, it was not possible to blind patients or therapists to the treatment received. All patients received treatment on the day of the initial examination. All patients receive two treatments (at the initial evaluation then another at the second visit) regardless of their group assignment. After the first two visits, patients completed the experimental procedures and therapists had the potential to perform follow-up appointments with the treatment being up to therapist and patient discretion.

Treatment

Mobilization group

Subjects were in prone and the therapist assessed by applying a central posterior to anterior (CPA) force to the spinous process (SP) of the patient at the C2 and C3 level, then a unilateral posterior to anterior (UPA) on either the articular pillar or lamina body C2 and C3 as well as the lateral mass of C1, with the intent of reproducing the patient's comparable sign. The force was applied in smooth/rhythmical oscillations and was used to determine the specific level and location where the therapist would target the mobilization technique. The therapist assessed the patient's response to force, looking to reproduce patient's comparable sign (reproduction of symptoms). Once the therapist identified the specific level and location, they perform the mobilization at that level for

30 seconds. Then the therapist repeated the mobilization using smooth/rhythmical oscillations two more times and recorded the level and technique. [26]

Manipulation group

Once the therapist assessed the patient and identified the patient's most comparable sign in the same process as in the manipulation group, they performed amanipulation at the end of the patient's available range, as described by Maitland. The manipulation was performed only once. The therapist performed either a localized cervical rotation manipulation which primary movement is rotation or a longitudinal cephalad C1 and C2 manipulation, both targeting the identified segment using the comparable sign in the upper cervical spine[26]. The selection of technique was performed in a pragmatic fashion based upon the assessment and at the discretion of the therapist.

To perform the localized cervical rotation manipulation the patient was in supine and the therapist used a chin hold performed on either the left or right side (depending on most comparable sign). The therapists used a thrusting knuckle to target the patient's articular pillar at the identified segment. The therapist rotated until they felt movement into the thrusting knuckle and then side bend away (if rotate right, they will side-bend left) until they identify end range, and then they carefully extended until they felt all three planes of movement locked or have tension. Once fine-tuned the therapist performed a high velocity, low amplitude manipulation to either the right or to the left depending on the comparable sign[26]. Figure 1 here

To perform the longitudinal cephalad C1-C2 manipulation the patient was in supine, the therapist used a traction manipulation for the CO-C2 joints as indicated by the comparable sign. The therapist stood at the side of the table facing in a cephalad direction. The therapist rotated the patients head away slightly to expose the mastoid process. The therapist hooked the mastoid process with the thrusting knuckle and performed a longitudinal manipulation. The therapist

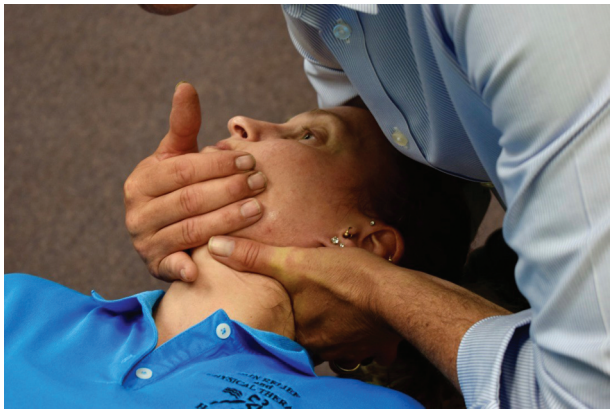


Figure 1. Cervical rotation manipulation.

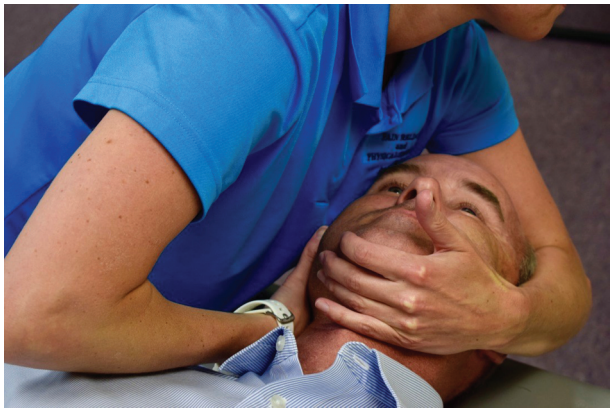


Figure 2. Longitudinal cephalad C1-C2 manipulation.

applied a high velocity, low amplitude manipulation-directed cranially[26]. Figure 2 here

In addition to receiving either the manipulation or mobilization, both groups were prescribed the same home exercise program (HEP) and given the same instructions and number of repetitions to perform. Exercise specifics can be found in Appendix A. Patients were also provided a form to track how often they performed or adhered to the HEP.

Finally, patients were asked to maintain their usual activities within the limits of pain and to avoid activities which aggravate symptoms. Patients were also instructed to maintain their current medication regimen throughout the course of the study and to avoid any other co-interventions.

Follow-up

All patients were scheduled for a follow-up within approximately two days (48-hours) of the initial examination and treatment. At the time of the follow-up patients again completed the NDI, the NPRS, the HIT-6, the GRC, the PASS, and ACROM measurements. Patients also reported and described any side effects and how long they lasted. Patients completed all outcome measures at discharge. At the time of the 1-month follow-up patients completed self report outcome measures.

Sample size determination

A priori power analysis was performed using G-power based on an effect size of 0.2 at the time of the second visit. Considering an alpha level equal to 0.05, and a desired power of 90%. The estimated desired sample was calculated to be 20 patients per group. A conservative drop out rate of 20% was expected, so a goal of 24 patients per group was planned.

Data analysis

Key baseline demographic variables including scores on the self-report measures were collected (Table 1).

Table 1. Baseline variables: demographics, outcome measures, selected physical impairments.

Variable	Mobilization (n = 24)	Manipulation (n = 21)
Age (years), mean (SD)	47.5 (17.7)	48.4 (15.5)
Gender: Female n (%)	15 (62.5%)	11 (52.4%)
Duration of symptoms (weeks), median	8	11
NDI (0-50), mean (SD)	16.5 (8.1)	17.7 (8.8)
NPRS, mean (SD)	5.0 (2.1)	5.5 (1.6)
HIT, mean (SD)	54.5 (9.1)	56 (7.7)

NPRS = Numeric Pain Rating Scale, 0–10, lower is better; NDI = Neck Disability Index, 0– 50, lower is better; HIT = Headache Impact Test, lower is better.

The primary aim (effects of treatment on disability and pain were examined with a mixed-model analysis of variance (ANOVA), with treatment group (manipulation versus mobilization) as the between subjects variable and time (baseline, second visit), discharge, and 1-month follow-up) as the within subjects variable. Separate ANOVAs were performed with disability, pain, the impact of headaches, and ACROM as the dependent variable. For each ANOVA, the hypothesis of interest was the 2-way interaction (group*time) with a p-value set at 0.05. Little's Missing Completely at Random (MCAR) Test was performed to determine if data were missing at random. Intention-to-treat analysis was performed by using expectation maximization technique in which missing data are estimated using regression equations[27].

A Mann Whitney U-test was used to determine difference for the GRC scores between groups at the follow-up periods. To account for the familywise error rate, the p-value was set at 0.017 for this analysis. Frequencies of success on the PASS were compared at discharge and one-month between groups using a χ^2 test of independence. Little's (MCAR) test was performed to determine if data were missing at random. Intention-to-treat analysis was performed by using expectation maximization technique in which missing data are estimated using regression equations. Data analysis was performed using the SPSS Version 26 statistical software package (SPSS Inc, Chicago, IL).

Results

Fifty-one patients with a primary report of headache were screened for eligibility to participate in this clinical trial. Forty-five patients mean age 47.8 (SD = 16.9) years (57.8%% female), met the eligibility criteria, agreed to participate and signed informed consent. Of these 45 patients presenting with cervicogenic headache, 24 were randomized to the mobilization group and 21 to the manipulation group. Figure 3 shows a flow diagram of patient recruitment and retention for this trial. All baseline demographics were similar between groups (Table 1). Of the 45 patients enrolled 42 (93%) completed the 1-month follow-up (Figure 3).

The overall group*time interaction for the mixed model ANOVA was not statistically significant for (Figure 4) NDI (p = 0.91, partial eta squared = 0.013), NPRS (p = 0.81), HIT (p = 0.89). Additionally, no significant interaction was found for cervical range of motion including flexion (p = 0.84), extension (p = 0.7), side bending right (p = 0.65), side bending left (p = 0.75), rotation right (p = 0.93) or rotation left (p = 0.95). However, both groups improved over time for all outcomes (p <.05). Table 2 shows the within group and between group improvements at baseline and at each follow-up period for NDI, NPRS, and HIT. Figure 4 shows the NDI scores for both groups at each follow-up period.

The Mann-Whitney U-test did not reveal a significant difference for the GRC between groups at 48-hours, discharge or the one-month follow-up for the GRC (Table 2). Additionally, there was no significant difference for the PASS at discharge (92% mobilization group and 95% manipulation group; p = 0.55) or at one-month follow-up (87.5% mobilization group and 100% manipulation group; p = 0.23). No side effects were reported for either group during the study period.

Discussion

To the best of our knowledge, this is the first randomized clinical trial examining the effects of a pragmatically applied approach manipulation versus mobilization for patients with cervicogenic headache. The results of the current study demonstrate that both groups experienced improvements in pain and function during the study period and at the time of follow-up. However, there were no between group differences for disability, pain, headache impact, or cervical range of motion. Additionally, there was no significant difference for GRC or the patient acceptable symptoms at discharge or the 1-month follow-up between groups. Although the manipulation group experienced an increase in the GRC the CIs crossed with the mobilization group meaning there could likely be no true effect. This suggests that manipulation and mobilization have similar effects on patients with cervicogenic headache when applied pragmatically.

These results differ from those of Dunning et al. [11] who found that individuals with cervicogenic headache who received manipulation to the upper cervical and thoracic regions had significantly greater outcomes in terms of disability and pain compared to the group that received mobilization. However, there are a few differences between the current study and that of Dunning et al. [11]. This trial used two sessions of manipulation, whereas the other trial used a frequency between six to eight manipulation procedures. Thus, it is possible that the differences between

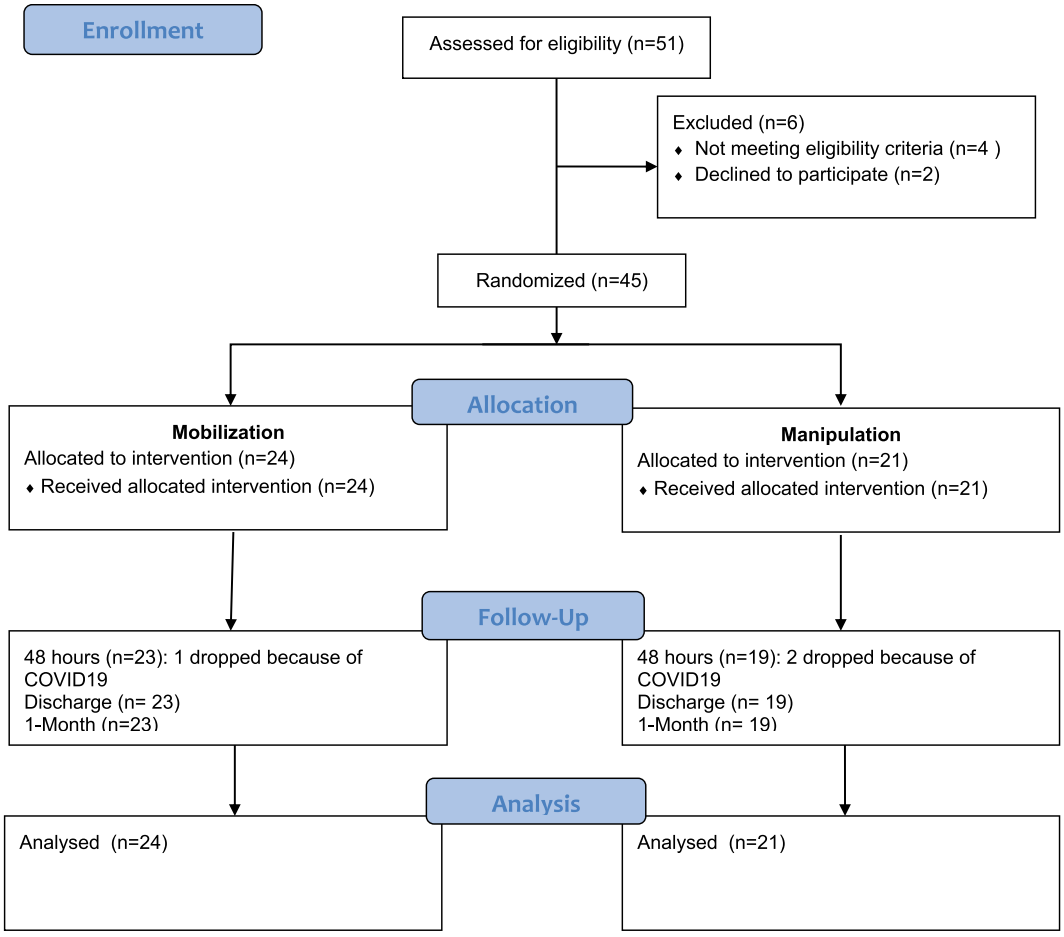


Figure 3. Flow diagram of subject recruitment and retention.

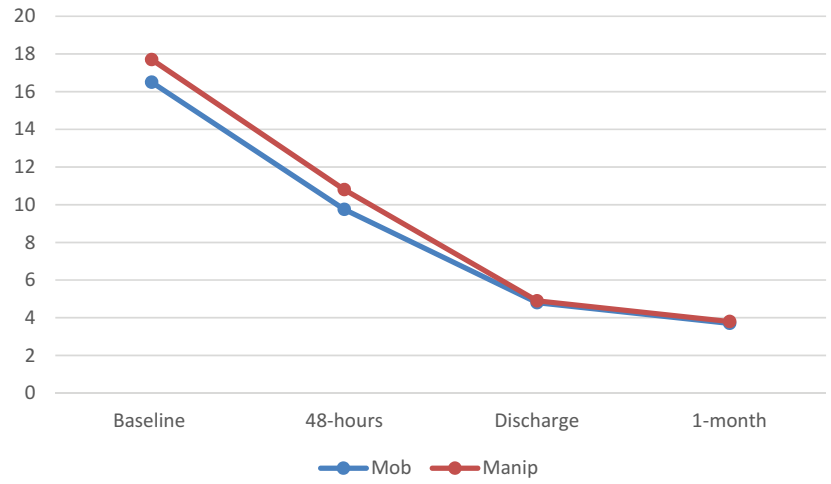


Figure 4. Neck Disability Index scores (0-50) at each time period for both groups.

studies can be related to dosage. Another difference is clearly the fact this trial used a pragmatic approach where clinicians identified the technique to use and the segment to treat whereas Dunning et al. [11] prescribed the same technique, and the location or which cervical segment to target.

The current study findings are like those of Griswold et al. [12] who examined a pragmatic approach to manipulation versus mobilization for the management of individuals with neck pain. The researchers found that when clinicians had the ability to assess and treat according to their findings there was no difference in terms of pain and disability. Furthermore, the results of our study are consistent with the systematic review by Roenz and colleagues [15] who found that studies using a prescriptive design for the use of manipulation versus mobilization for neck and low back pain typically experienced a significant difference in outcomes whereas those that use a pragmatic study did not. Interestingly when clinicians use their own decision-making, the effects of

Table 2. Comparisons for differences in change scores. ($^{\Delta}$ values represent mean difference from baseline to follow-up with SD).

Variable	Mobilization (n = 24)	Manipulation (n = 21)	Between Group Differences$^{\Delta}$ (95%CI)	P Value
Neck Disability Index (0-50)				
Baseline (SD)	16.5 (8.1)	17.7 (8.8)		
48-hours (SD)	9.75 (7.2)	10.8 (5.6)		
Baseline to 48-hours$^{\Delta}$	−6.7 (6.2)	−6.9 (7.2)	−0.14 (−4.2, 3.9)	0.95
Discharge (SD)	4.8 (4.3)	4.9 (4.4)		
Baseline to Discharge$^{\Delta}$	−11.7 (7.4)	−12.8 (7.8)	−1.1 (−5.7, 3.4)	0.62
1-month follow-up (SD)	3.7 (3.6)	3.8 (2.9)		
Baseline to 1-month follow-up$^{\Delta}$	12.8 (9.2)	13.9 (8.0)	−1.1 (−5.6, 3.4)	0.68
Numeric Pain Rating Scale				
Baseline (SD)	5.0 (2.1)	5.5 (1.6)		
48-hours (SD)	2.7 (1.9)	2.8 (1.4)		
Baseline to 48-hours$^{\Delta}$	−2.3 (3.0)	−2.7 (1.6)	−.39 (−1.8, 1.1)	0.60
Discharge (SD)	1.8 (1.7)	1.7 (0.9)		
Baseline to Discharge$^{\Delta}$	−3.2 (2.9)	−4.0 (1.5)	−.78 (−2.1, 6.2)	0.27
1-month follow-up (SD)	1.5 (1.1)	1.2 (1.4)		
Baseline to 1-month follow-up$^{\Delta}$	−3.4 (2.6)	−4.5 (2.2)	−.98 (−2.4,.45)	0.18
Headache Impact Test				
Baseline (SD)	54.5 (9.1)	56 (7.7)		
Discharge (SD)	44.5 (8.7)	45.0 (8.9)		
Baseline to Discharge$^{\Delta}$	−10 (8.6)	−11.1 (7.4)	−1.1 (−6.0, 3.7)	0.64
1-month follow-up (SD)	42.6 (7.3)	43.6 (6.4)		
Baseline to 1-month follow-up$^{\Delta}$	11.9 (7.9)	12.6 (7.3)	−.67 (−5.3, 3.9)	0.77
Global Rating of Change				
48-hours	1.7 (2.6)	3.1 (1.9)	1.4 (0.04, 2.8)	0.03*
Discharge	4.5 (1.6)	5.2 (1.8)	.65 (−0.39, 1.7)	0.10
1-month follow-up	4.9 (2.2)	5.8 (1.2)	.95 (−0.14, 2.0)	0.07

*Not significant considering the familywise error rate correction for multiple tests of p = 0.017.

mobilization are similar to manipulation. However, an alternative thought is that when clinicians use their own decision-making, the effects of manipulation are not realized as much as they could be if they performed them prescriptively[28, 29]. Interestingly, Donaldson et al. [14] found there was no difference between a pragmatic and prescriptive approach to manipulation for individuals with low back pain with the exception of patient reported change at 6-month in favor of the group that received therapist-selected techniques. However, this study has not been performed in individuals with cervicogenic headache and requires further investigation.

It does appear that the mechanistically designed studies with strong internal validity consistently have found manipulation has superior outcomes to mobilization for individuals with neck and low back pain[15]. The pragmatic approach used in this clinical trial is likely more generalizable to actual clinical practice, although both studies designs are needed yet, clinicians looking to research for guidance with decision-making are best served by studies with a pragmatic design[29]. Interestingly when clinicians use their own decision-making, the effects of manipulation are similar to mobilization. Future studies should investigate the impacts of clinical decision-making on patient outcomes.

Limitations

There are several limitations that should be considered. First patient recruitment stopped before we reached our target sample size of 48 as a result of COVID-19. However, with the 45 patients enrolled and the lack of significant findings we are confident that recruiting another three patients would not change. However, it is possible that the study was underpowered to detect a true difference. Additionally, we did not include a true control group, hence patients enrolled in the current trial may have improved as a result of the interventions they received or simply the natural history of the disorder. Finally, there were only four recruiting and treating therapists treating patients which may limit generalizability.

Conclusion

The results of this study demonstrated that there is no significant difference between manipulation and mobilization when applied in a pragmatic fashion for the management of cervicogenic headache in terms of pain and disability. Future studies should continue to examine the impacts of therapist clinical decision making in the selection and utilization of manual therapy.

Acknowledgments

We would like to thank Alex Ivashenko and Dhaval Talati for their participation in recruitment and treatment of patients in this clinical trial. We would also like to thank all the participants who agreed to participate in this study.

Disclosure statement

Josh Cleland teaches manual therapy courses which often include techniques used in this clinical trial.

Funding

No funding was provided for this project.

ORCID

Bryan O'Halloran http://orcid.org/0000-0002-3234-3521
Megan Donaldson http://orcid.org/0000-0002-4925-6512
Joshua A. Cleland http://orcid.org/0000-0002-1930-6208

Data availability statement

The data set resides with the authors of the manuscript.

Geolocation information

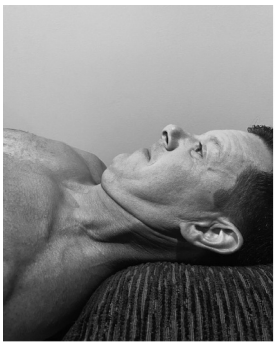
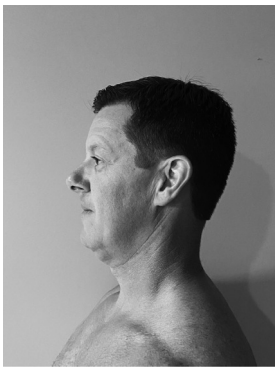
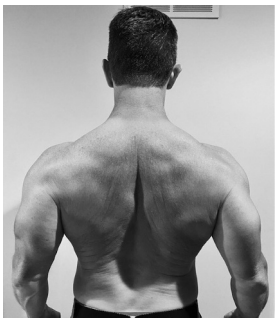
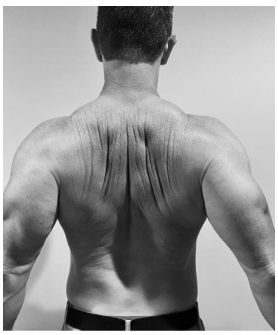
Data for this study were collected from Physical Therapy Clinics Located in Pennsylvania and New Jersey.

References

[1] Lipton RB, Stewart WF. Evaluating the IHS criteria. Cephalalgia. 1994;14(1):3–4.
[2] Stovner L, Hagen K, Jensen R, et al. The global burden of headache: a documentation of headache prevalence and disability worldwide. Cephalalgia. 2007;27(3):193–210.
[3] Antonaci F, Fredriksen TA, Sjaastad O. Cervicogenic headache: clinical presentation, diagnostic criteria, and differential diagnosis. Curr Pain Headache Rep. 2001;5: 387–392.
[4] Headache Classification Committee of the International Headache S. The International Classification of Headache Disorders, 3rd edition (beta version). Cephalalgia. 2013;33 (9):629–808.
[5] Knackstedt H, Bansevicius D, Aaseth K, et al. Cervicogenic headache in the general population: the Akershus study of chronic headache. Cephalalgia. 2010;30(12):1468–1476.
[6] Nilsson N. The prevalence of cervicogenic headache in a random population sample of 20-59 year olds. Spine (Phila Pa 1976). 1995;20(17):1884–1888.
[7] Hall T, Chan HT, Christensen L, et al. Efficacy of a C1-C2 self-sustained natural apophyseal glide (SNAG) in the management of cervicogenic headache. J Orthop Sports Phys Ther. 2007;37(3):100–107.
[8] Zito G, Jull G, Story I. Clinical tests of musculoskeletal dysfunction in the diagnosis of cervicogenic headache. Man Ther. 2006;11(2):118–129.
[9] Blanpied PR, Gross AR, Elliott JM, et al. Neck Pain: revision 2017. J Orthop Sports Phys Ther. 2017;47(7):A1–A83.
[10] Boyling JD, Palastanga N, Grieve GP. Grieve's Modern Manual Therapy: the Vertebral Column. 2nd. St. Louis, MO: Churchill Livingstone; 1994.
[11] Dunning JR, Butts R, Mourad F, et al. Upper cervical and upper thoracic manipulation versus mobilization and exercise in patients with cervicogenic headache: a multi-center randomized clinical trial. BMC Musculoskelet Disord. 2016;17:64.
[12] Griswold D, Learman K, Kolber MJ, et al. Pragmatically applied cervical and thoracic nonthrust manipulation versus thrust manipulation for patients with mechanical neck pain: a multicenter randomized clinical trial. J Orthop Sports Phys Ther. 2018;48(3):137–145.
[13] Relton C, Torgerson D, O'Cathain A, et al. Rethinking pragmatic randomised controlled trials: introducing the "cohort multiple randomised controlled trial" design. BMJ. 2010;340:c1066.
[14] Donaldson M, Petersen S, Cook C, et al. A prescriptively selected nonthrust manipulation versus a therapist-selected nonthrust manipulation for treatment of individuals with low back pain: a randomized clinical trial. J Orthop Sports Phys Ther. 2016;46(4):243–250.
[15] Roenz D, Broccolo J, Brust S, et al. The impact of pragmatic vs. prescriptive study designs on the outcomes of low back and neck pain when using mobilization or manipulation techniques: a systematic review and meta-analysis. J Man Manip Ther. 2018;26(3):123–135.
[16] Vernon H. The psychometric properties of the Neck Disability Index. Arch Phys Med Rehabil. 2008;89 (7):1414–1415.
[17] Sauro KM, Rose MS, Becker WJ, et al. HIT-6 and MIDAS as measures of headache disability in a headache referral population. Headache. 2010;50(3):383–395.
[18] Jensen MP, Karoly P, Braver S. The measurement of clinical pain intensity: a comparison of six methods. Pain. 1986;27(1):117–126.
[19] Young IA, Dunning J, Butts R, et al. Psychometric properties of the numeric pain rating scale and neck disability index in patients with cervicogenic headache. Cephalalgia. 2019;39(1):44–51.
[20] Price D, Bush F, Long S, et al. A comparison of pain measurement characteristics of mechanical visual analog and simple numerical rating scales. Pain. 1994;56(2):217–226.
[21] Farrar J, Young JJ, La Moreaux L, et al. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. Pain. 2001;94:149–158.
[22] Cleland JA, Childs JD, Fritz JM, et al. Interrater reliability of the history and physical examination in patients with mechanical neck pain. Arch Phys Med Rehabil. 2006;87(10):1388–1395.
[23] Jaeschke R, Singer J, Guyatt G. Measurement of health status. Ascertaining the minimal clinically important difference. Controlled Clin Trials. 1989;10(4):407–415.
[24] Tubach F, Dougados M, Falissard B, et al. Feeling good rather than feeling better matters more to patients. Arthritis Rheum. 2006;55(4):526–530.
[25] Kvamme MK, Kristiansen IS, Lie E, et al. Identification of cutpoints for acceptable health status and important improvement in patient-reported outcomes, in rheumatoid arthritis, psoriatic arthritis, and ankylosing spondylitis. J Rheumatol. 2010;37(1):26–31.
[26] Maitland G. Vertebral manipulation. 5th ed. Sydney, New South Wales, Australia: Butterworths; 1986.
[27] LH R. Methods for handling data in the behavioral neurosciences: don't throw the baby out with the bath water. J Undergraduate Neurosci Educ. 2007;5: A71–A77.
[28] Kent P, Marks D, Pearson W, et al. Does clinician treatment choice improve the outcomes of manual therapy for nonspecific low back pain? A metaanalysis. J Manipulative Physiol Ther. 2005;28(5):312–322.
[29] Rowbotham MC, Gilron I, Glazer C, et al. Can pragmatic trials help us better understand chronic pain and improve treatment? Pain. 2013;154(5):643–646.

Appendix A. Guidelines for exercise

Home Exercise Program: all subjects were prescribed the same home exercise program as follows.

Picture:	Exercise	Description	Sets and Repetitions
	Supine chin tuck with cervical nod (neck flexion)	While lying on your back with rolled towel under your neck. Tuck your chin down as if you are making a double chin. The attempt to gently curl your chin toward your chest trying to lift the back of your head off the table. Hold 5–10 seconds then return to starting position.	Perform 10x and hold 10 seconds 3x a day
	Seated chin tuck	With good sitting posture, tuck chin back as far as possible. Repeat with each rep trying to move further back.	3–5 repetitions holding for 3–5 seconds every 1–2 hours daily
	Scapular depressions	Start by squeezing your shoulder blades together. Next, push your arms down toward the floor. As you do this, your shoulders should drop a few inches. Always keep your elbows straight and wrists extended.	3–5 repetitions hold 3–5 seconds every 1–2 hours Progress as tolerated with therapist discretions introducing Thera bands or longer holds
	Scapular retractions	Draw your shoulder blades back and down.	3–5 repetitions hold 3–5 seconds every 1–2 hours Progress as tolerated per therapist discretion using resistance bands