0008-3194/99/111–119/$2.00/©JCCA 1999

The effect of spinal manipulative therapy (SMT) on pain reduction and range of motion in patients with acute unilateral neck pain: a pilot study

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Objective: *This experiment evaluated the response of acute neck pain patients to an intervention utilizing a single manipulation to either a) the same side of pain (ipsilateral) or b) opposite side (contralateral) and compared the results to a placebo group.*

Design: *In this pre-test – post-test study, 36 subjects were randomly allocated to one of the three groups:*

(1) SMT applied to the same side as the pain (ipsilateral)
(2) SMT applied to the side opposite the pain (contralateral)
(3) A placebo group receiving only detuned ultrasound therapy

Subjects: *In a private chiropractic office, patients with acute unilateral neck pain and stiffness were studied. Inclusion criteria included the presence of acute unilateral neck pain, no prior similar history, no history of trauma, and no neurological deficit. Subjects had no previous chiropractic treatment of the cervical spine.*

Intervention: *Patients in the two manipulation groups received a single cervical manipulation. Patients in the placebo group received detuned ultrasound therapy over the area of pain.*

Main Outcome Measures: *There were two outcome measures. Pain intensity was rated on the 100 mm. visual analog scale (VAS) prior to and immediately following the intervention. Pre and Post test measurements of cervical spine range of motion utilizing the CROM instrument were also taken.*

Results: *Degrees of ipsilateral lateral flexion, contralateral flexion, and VAS improved when ipsilateral versus contralateral spinal manipulative therapy was applied.*

Objectif : *La présente étude vise à évaluer la réaction de patients souffrant de cervicalgie aiguë à un traitement comportant une seule manipulation pratiquée a) du même côté que la douleur (ipsilatérale) ou b) du côté opposé à la douleur (controlatérale) et à comparer les résultats obtenus avec ceux d'un groupe soumis à un traitement placebo.*

Conception : *L'étude, qui comporte une étape pré-traitement et une étape post-traitement, s'effectue sur 36 sujets répartis au hasard dans l'un des trois groupes de traitement suivants :*

(1) manipulation cervicale seule, pratiquée du même côté que la douleur (ipsilatérale);
(2) manipulation cervicale seule, pratiquée du côté opposé à la douleur (controlatérale);
(3) ultrasons au moyen d'un appareil déréglé (groupe placebo).

Sujets : *L'étude a été menée dans un cabinet privé de chiropratique où se sont présentés des patients souffrant d'une cervicalgie unilatérale aiguë et de raideur. Les critères d'inclusion comprenaient la présence d'une cervicalgie unilatérale aiguë ainsi que l'absence d'antécédents de douleur semblable, de traumatisme et de déficience neurologique. Les sujets n'avaient jamais subi de traitement chiropratique de la colonne cervicale.*

Intervention : *Les patients appartenant aux groupes de traitement ipsilatéral et controlatéral ont été soumis à une seule manipulation de la région cervicale, tandis que ceux qui appartenaient au groupe placebo ont été soumis à un traitement aux ultrasons au moyen d'un appareil déréglé, appliqué sur la région douloureuse.*

Principaux outils de mesure : *Deux outils de mesure ont été utilisés. Tout d'abord, la douleur a été évaluée*

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In partial fulfillment for requirements for the College of Chiropractic Sciences Field-Practioner Program.

***Conclusions**: Immediately following a single manipulation to acute neck pain patients there is less pain intensity and a greater range of motion when spinal manipulative therapy is applied to the side of neck pain versus manipulation on the side opposite the pain or to a placebo group.*
(JCCA 1999; 43(2):111–119)

KEY WORDS: cervical spine, acute pain, manipulation, CROM, chiropractic.

avant et immédiatement après le traitement sur une échelle analogique visuelle (VAS) de 100 mm. Ensuite, l'amplitude des mouvements de la colonne cervicale a été mesurée avant et après le traitement au moyen du CROM.

***Résultats** : Une amélioration de la flexion latérale ipsilatérale et de la flexion controlatérale ainsi qu'une diminution de la douleur sur la VAS ont été observées dans les cas de manipulation ipsilatérale par rapport aux cas de manipulation controlatérale.*

***Conclusion** : La manipulation de la colonne cervicale pratiquée du même côté que la douleur cervicale permet, immédiatement après une seule manipulation, une diminution plus marquée de la douleur et une amplitude plus grande des mouvements de la colonne cervicale que la manipulation de la colonne cervicale pratiquée du côté opposé à la douleur cervicale ou que le traitement placebo.*
(JACC 1999; 43(2):111–119)

MOTS CLÉS : colonne cervicale, douleur aiguë, manipulation, CROM, chiropratique

Introduction

Neck pain is a frequent and disabling complaint in the general population.[1,2] In neck pain studies, the prevalence ranged from 10% to 72% depending on work tasks, type of design, or activities of daily living.[2–4]

One of the most common causes of neck pain is mechanical dysfunction of the cervical spine.[5] The exact nature of this pathology remains obscure. Most patients will improve with time but as many as one-third can suffer recurring pain up to 15 years later.[6]

Spinal manipulative therapy (SMT) or adjustment has been the subject of numerous studies with varying conclusions regarding its efficacy. SMT is thought to exert a reflex effect on pain and muscle tension. It has been thought that mechanical stimulation of joint capsule proprioceptors and muscle spindles can result in reflex inhibition of pain, reflex muscle relaxation and improved segment kinematics.[7–10]

Cassidy, Lopes, and Yong-Hing[11] demonstrated that a single manipulation was more effective than mobilization in decreasing pain in patients with mechanical neck pain. In their study one hundred consecutive outpatients suffering from mechanical neck pain with radiation into the trapezius muscle were selected. Fifty-two subjects were manipulated and 48 subjects were mobilized. The patients rated their pain intensity on the NRS-101 pain scale instrument. They also received a goniometric assessment. Gain scores for pain and range of motion were compared.

In an uncontrolled study, Cassidy et al.[12] also showed that a single manipulation increased cervical rotation and lateral flexion. Fifty consecutive outpatients suffering from unilateral neck pain with radiation into the trapezius were selected for this study. These patients rated their pain intensity on the NRS-101 pain scale instrument and they also received a goniometric assessment.

Nordemar[13] compared manipulation with cervical collar use and transcutaneous nerve stimulation in 30 patients with acute neck pain. Some of the patients receiving manipulation had remarkably rapid symptom reduction and improved range of motion.

Other studies have demonstrated that manipulation is an effective form of therapy for a variety of neck complaints.[14–17] BenEliyahu[14] reported that patients with and without nerve root compression respond well to chiropractic care and that it should be employed prior to more invasive treatment.

Osterbauer et al.[15] produced results that show that spinal manipulative therapy may be beneficial to some patients with neck pain from injury, however, only 10 subjects were included in the study and the main intervention consisted of short lever manually assisted adjustments using the Activator instrument.

Sloop et el.[16] randomized 39 patients into 2 groups. All patients were given an amnesic dose of diazepam. Twenty one patients received a single manipulation and 18 served as controls. Results favoured the manipulation group but the authors reported that the differences were not statistically significant.

Manipulation was used as the major intervention in the following studies, however, none used a control group. Howe et al.[18] conducted a randomized controlled trial on 51 patients divided into 2 groups, one using manipulation, and the other using medication. The results showed that the manipulated group had immediate improvement in ROM and more relief from pain following treatment. However, after one week, both groups reported improvement.

Maigne,[19] Grieve,[20] Cassidy,[12] and Schaffer and Faye[21] described manipulative techniques for restricted rotation of the cervical spine. All theorized that the joint cavitation occurs on the side of the thrust. Good,[22] in his analysis of Diversified type adjustments, reported that the greater the amount of lateral flexion towards the side of contact, the more likely the joint opposite the segmental contact point will release.

Reggars and Pollard,[23] in their study of 50 asymptomatic subjects, tried to determine if there was a relationship between the side of head rotation and the side of joint crack during Diversified rotary manipulation of the cervical spine. Their results showed that forty-seven of the fifty (94%) exhibited cracking on the ipsilateral side to head rotation (opposite side of the thrust). The three patients who exhibited cracking on the contralateral side to head rotation had all suffered from previous neck trauma suggesting that previous neck trauma may have an influence on the side of the joint crack.

This pilot study is not intended to clearly define any deficiencies in the literature. It was designed to use spinal manipulative therapy as an intervention and to assess the immediate effect of a single spinal manipulation to acute neck pain patients on pain intensity and range of motion when comparing the side of manipulative contact. A recently published survey reported the most commonly used treatment techniques of Canadian chiropractors. Christensen[24] reported that the most commonly used technique was Diversified (SMT) followed by sacro-occipital technique (SOT) then the mechanically assisted device (MAD) or Activator instrument.

At present, there are no guidelines as to where the contact should take place. Patients receiving only detuned ultrasound therapy over the area of pain were used as a control. This study was designed to determine which side of contact would be the most efficacious.

The following hypotheses were tested:

1 VAS will show greater improvement in the spinal manipulative therapy groups when compared to the placebo group ($p = .05$).

2 VAS will show greater improvement in the ipsilateral SMT group when compared to the contralateral SMT group ($p = .05$).

3 After spinal manipulative therapy, range of motion in the six conventional movements of the cervical spine is greater in the two spinal manipulative therapy groups, compared to the placebo group ($p = .05$).

4 Of the two experimental SMT groups, range of motion is greater in the ipsilateral SMT group when compared to the contralateral SMT group ($p = .05$).

Materials and methods

Subjects: All patients met inclusion criteria of unilateral neck pain and stiffness for less than two weeks and a self report of good general health. Exclusion criteria included the following:

- radiculitis or pain into the arm or hand
- neurological deficits of the brachial plexus roots
- history of fracture, tumor, infection, spondyloarthropathy
- history of trauma
- previous treatment by spinal manipulative therapy of the cervical spine

- history of any other treatment of the cervical spine (physiotherapy, medication)
- previous neck surgery
- workers' compensation or disability insurance issues
- a condition potentially aggravated by electrical devices, i.e. heart pacemaker

All patients signed a consent form and had the possible treatments explained. A random number table was utilized to allocate each patient to one of each of the three treatment groups. Randomization occurred when an independent person (the assistant) chose a number from a random numbers list. This procedure allocated the patient to one of the three groups.

Outcome measures

Visual Analog Scales: The visual analog scale was a 100 mm. line with pain descriptors marked "good" at one end and "bad" at the other. The subject was asked to rate the intensity of pain prior to the intervention and immediately following it. Perceived pain level was reported by marking the VAS with a perpendicular line. This mark was measured in mm. from the same end of the 100 mm. line in all patients. In general, this method of clinical pain assessment has been shown to be reliable and valid and seems to be the most sensitive. The VAS provides the patient with a robust, reproducible method of expressing pain severity. Results correlate well with other methods of measuring pain. The method is applicable to all patients regardless of language and can be used by children aged 5 or more years.[25–27] Wallace et al.[28] also suggested that the VAS was reliable and was superior to other pain measurement instruments because, compared with a seven-point scale, it enabled patients to discriminate better any small differences. Duncan et al.[29] also suggested that the VAS provided more reliable results when compared to a verbal measuring scale.

Range of Motion: Range of motion was assessed with a goniometer. The instrument used was the cervical-range-of-motion (CROM) instrument manufactured by Performance Attainment Associates (St. Paul, Minnesota). Six conventional movements of the cervical spine (i.e. neck flexion, extension, and left and right components of lateral flexion and rotation) were all measured by the primary investigator. The investigator stood in front of the subject with his hands on the subject's shoulders to prevent movement which would influence the readings. The subject was instructed to move their neck to their extreme limit until pain was reported or shoulder movement was detected. The dial meters were read in increments of 1 degree. The CROM instrument has been shown to be a reliable method of measurement in the past.[30,31] Youdas et al.[31] compared three methods of examining cervical active range of motion (AROM). The CROM instrument was compared to the use of a universal goniometer and visual estimation. Active range of motion measurements with the CROM instrument demonstrated good intratester and intertester reliability. The intraclass correlation coefficients (ICCS) were generally greater than .80 whereas the universal goniometer and visual estimation had ICCS less than .80. They concluded that the CROM device was the most reliable testing instrument. To minimize repositioning errors the nose bridge and the ears were used as anatomical landmarks.

Research procedure

Interventions: The primary investigator, a chiropractor, examined consecutive subjects at presentation using motion palpation to determine areas of cervical joint fixation. The investigator then delivered one of 3 interventions chosen at random by an assistant using a random numbers table.

Treatment protocols

- *Spinal Manipulation:* The subject was placed in a comfortable supine position on the treatment table. An open hand contact with the second finger was placed adjacent to the articular pillars of the mid cervical spine. The head was rotated contralaterally and slightly extended passively to the end of the physiologic range of motion. Once this was achieved a short lever, high velocity, and low amplitude thrust was applied. An audible crack was heard.
- *Detuned Ultrasound (Placebo) Therapy:* The subject was placed in a seated position with the area of pain exposed so that the conductive gel could be applied. The subject sat with their back toward the ultrasound unit so they could not see the unit. The timer was set for eight minutes and the current was turned to the off position. The transducer head was applied over the area of pain in a gradual circular movement simulating a treatment (placebo).

Subjects: There were 36 patients randomized to one of the three treatment groups. The patients in the manipulation group were unaware as to which of the two manipulation groups they would be in. Twelve patients received manipulation on the side of pain (ipsilateral) (Group 1). Group 2 (12 patients) received manipulation on the side opposite the pain (contralateral) and Group 3 (12 patients) received detuned ultrasound (placebo) therapy over the side of pain. The patients were allowed to move their head and neck following the intervention and they were given a post-treatment VAS and orally instructed to record their perceived pain with a perpendicular line. A post-treatment goniometric examination was completed utilizing the CROM instrument measuring all six ranges of motion.

Data Analysis Strategy: Mean scores were calculated for pre- and post-VAS and CROM results. Differences between pre and post measures were calculated and one-way Analyses of Variance (ANOVA) were conducted. The post hoc TUKEY-HSD test was used to detect significant differences between the 3 groups ($p < .05$).

Results

Twelve patients, mean (SD) age 39.5 (5.92) received manipulation on the side of pain (Group 1). Eight females and four males were in this group. Group 2 (12 patients) mean (SD) age 42.6 (7.78) received manipulation on the side opposite the pain. There were eleven females and one male in this group. Group 3 (12 patients) mean (SD) age 44.2 (6.98) received detuned ultrasound therapy over the side of pain. There were nine females and three males in this group.

The results on the pre and post measures for each of the outcome measures are outlined in Table 2. All three groups showed a decreased mean in VAS scores with the largest drop occurring sharply in the ipsi SMT group from 42.5 to 23.6. In the contra SMT and control groups, the drop in VAS score is much smaller. The mean changes in ROM increased in both spinal manipulation groups only, in all ranges. The ipsi SMT had greater improvements com-

Table 1
Summary of trials of manual therapy for neck pain

Reference	Treatment	Outcome
Brodin (1982)	mobilization for neck pain	mobilization decreases neck pain
Cassidy et al. (1992)	SMT vs. mobilization	SMT > mobilization decreasing pain
Cassidy et al. (1992)	single manipulation	single manipulation increases cervical rotation
Nordemar, Thorner (1981)	SMT vs. collar, TENS	SMT > collar, TENS in decreasing pain and increasing ROM
Beneliyahu (1994)	SMT for disc herniation and nerve root compression	SMT good for patients with or without nerve root compression
Osterbauer (1992)	SMT for neck injury	SMT good for neck injury
Sloop et al. (1982)	single SMT	SMT decreases neck pain
Howe et al. (1983)	single SMT vs. medication	SMT > medication in increasing ROM and decreasing pain.

pared to the contra SMT group. In the placebo group, the VAS score went down but the ROM measures changed very little.

The differences between the seven pre and post measures were calculated for each subject in each group. One way analyses were conducted to determine if there were any significant mean differences between the 3 groups. The results of the 7 one way analyses of variance are summarized in Table 3. At least one of the groups significantly differed on the VAS differences (F Ratio = 13.107, 2,33 df, $p = .0005$). Similarly at least one of the three groups significantly differed from the others on extension ($p = .04$), ipsi rotation ($p = .02$), ipsilateral flexion ($p = .0005$), and contralateral flexion ($p = .016$).

To determine which group was significantly different from the others, post hoc tests were conducted. The results are summarized in Table 4. VAS scores are significantly different for the ipsi SMT group when compared to the other two groups. This finding supports Hypothesis 2. The contra SMT group, however, does not significantly differ from the placebo group. This finding does not support Hypothesis 1 for the contra SMT group.

Table 2
Pre and post outcome measures by group

	Group 1 *N* = 12		**Group 2** *N* = 12		**Group 3** *N* = 12	
Outcome Measure	**Pre** $\bar{X}$**(SD)**	**Post** $\bar{X}$**(SD)**	**Pre** $\bar{X}$**(SD)**	**Post** $\bar{X}$**(SD)**	**Pre** $\bar{X}$**(SD)**	**Post** $\bar{X}$**(SD)**
VAS	42.5 (19.8)	23.6 (18.6)	44.1 (27.5)	41.4 (28.4)	50.4 (22.5)	46.5 (21.8)
Range of Motion						
Flexion	53.7 (15.1)	58.8 (15.6)	46.0 (16.6)	49.8 (14.6)	46.5 (10.0)	46.0 (11.4)
Extension	52.0 (13.3)	57.3 (11.3)	45.5 (11.9)	46.0 (12.4)	48.5 (15.6)	48.2 (15.9)
Ipsi Rotation	52.0 (13.1)	61.2 (9.7)	50.7 (8.9)	53.8 (9.1)	47.8 (22.6)	49.8 (19.7)
Contra Rotation	65.2 (19.3)	70.5 (17.4)	61.2 (10.5)	63.0 (10.0)	54.1 (15.6)	55.2 (16.1)
Ipsilateral Flexion	26.2 (10.8)	34.4 (10.7)	26.3 (10.9)	28.3 (10.6)	32.7 (15.2)	32.1 (16.0)
Contralateral Flexion	34.5 (7.1)	40.5 (5.5)	34.3 (7.2)	35.2 (8.3)	31.9 (10.4)	32.1 (9.7)

Table 3
One way analysis of variance results on seven outcome measures by group (2,33df)

Outcome measures	**F Ratio**	**Significance**
VAS	13.107	.0005
Range of Motion		
Flexion	3.107	.058
Extension	3.502	.042
Ipsi Rotation	4.332	.021
Contra Rotation	1.493	.241
Ipsilateral Flexion	13.949	.0005
Contralateral Flexion	4.676	.016

Degrees of flexion and contralateral rotation showed no significant mean difference between the three groups. Degrees of extension showed a statistically significant difference between ipsilateral (Group 1) spinal manipulation and the placebo group. A significant difference is also seen between Group 1 and the placebo group in ipsilateral rotation. This suggests some support for Hypothesis 3. Significant increases in ipsilateral and contralateral lateral flexion were seen between ipsilateral (Group 1) SMT and contralateral (Group 2) SMT, as well as between ipsilateral (Group 1) SMT and the placebo group. These findings suggest some support for Hypothesis 4.

Discussion

The results of this pilot study demonstrate clinically significant results when comparing three interventions. SMT of the cervical spine has the immediate effect of decreasing pain and increasing range of motion. The greatest improvement was in lateral flexion followed by ipsilateral rotation. Cassidy et al.[11] found that ipsilateral rotation followed by contralateral flexion was greater following a single intervention of SMT to one side compared to mobilization, however, reported differences were not found to be statistically significant.

Cassidy et al.[12] also found that SMT had an immediate effect of decreasing pain. They showed that there was a significant relationship between a decrease in pain and an increase in ipsilateral rotation ($p < .0005$) and contralateral rotation ($p < .005$). Their study was not controlled and does not demonstrate the efficacy of manipulative treatment. Because of the small sample size of their study there is a greater probability of creating a type II error.

The problem of most trials is that of sample size. This pilot study did have small sample sizes which may affect the uniformity or homogeneity between the groups. Small sample sizes are subject to erroneous measures that are sensitive to large treatment effects and as such likely to commit type II errors for each outcome measure. The present pilot study also demonstrates the likelihood that a real treatment effect will go undetected (type II error). In order to complete a trial of SMT to rank pain and range of motion a sample size estimate should be completed to overcome the problem. From this pilot study a sample size estimate was calculated using a power of .80, an alpha of .05, the mean difference of all the outcome measures, and the smallest standard deviation. It was determined that a total of 78 subjects for each group would be required for a total of 234 subjects.

Another problem in this study was that the examiner was also the treating practitioner and bias may have been created. This bias may be represented by examiner expectation of superior results of one intervention over another. The subjects were the treating practitioner's patients. Therefore, reported results may have been over-rated to

Table 4
Post-hoc treatment comparisons between groups by significance level

	Group 1 vs Group 2	Group 1 vs Group 3	Group 2 vs Group 3
Outcome Measure			
VAS	.0005	.001	.934
Range of motion			
Flexion	.899	.064	.153
Extension	.107	.05	.931
Ipsi Rotation	.065	.027	.922
Contra Rotation	.388	.252	.956
Ipsilateral Flexion	.033	.0005	.303
Contralateral Flexion	.048	.023	.946

please the treating practitioner. This problem would be overcome if the examiner was a third party and was blind to the intervention that was administered.

It should be noted from the results of this pilot study that following a single manipulation there is less pain and a greater range of motion when manipulation is conducted on the side of neck pain (ipsilateral SMT) versus manipulation on the side opposite (contralateral SMT) or a placebo (detuned ultrasound). These results were obtained from subjects suffering from acute neck pain only and only when one intervention was administered. In the clinical setting, spinal manipulative therapy is usually administered over a course of treatments with the long term goal of pain relief. This is not usually obtained following a single office visit.

Some readers may want to see the results of this study compared to other studies. Because there are not many studies dealing with laterality of treatment this author decided that the results of this pilot study would not warrant comparison at this time.

There are no trials of SMT for long term relief for either acute or chronic neck pain. It is therefore necessary to develop and undertake research in this field to determine the best therapeutic approach when utilizing SMT in mechanical neck pain patients. It may also be interesting to note the number of manipulations required to completely reduce pain and restore normal joint motion in the cervical spine.

Conclusions

This pilot study demonstrates that VAS shows greater improvement when ipsilateral spinal manipulative therapy is used versus contralateral spinal manipulative therapy or a placebo when used on patients with mechanical neck pain. This is an immediate effect and it is statistically significant ($p < .05$). Spinal manipulative therapy at the side of neck pain led to statistically significant ($p < .05$) increases in lateral flexion to both sides followed by ipsilateral rotation.

Further studies with larger sample sizes are required to support the efficacy of SMT for mechanical neck pain. It is hoped that the results of this pilot study will provide a basis for further work in an attempt to demonstrate the effectiveness of ipsilateral SMT in reducing pain and increasing ROM in patients with mechanical neck pain.

It is also hoped that the study limitations as noted earlier be addressed in a future full study.

Acknowledgements

The author gratefully acknowledges the help of Carol Hagino with the statistical analysis of the data within this manuscript. Special thanks are also in order to Dr. Judith Waalen for her assistance in the preparation of this report.

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