A comparison of two non-thrust mobilization techniques applied to the C7 segment in patients with restricted and painful cervical rotation

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Objectives: Cervical mobilization and manipulation have been shown to improve cervical range of motion and pain. Rotatory thrust manipulation applied to the lower cervical segments is associated with controversy and the potential for eliciting adverse reactions (AR). The purpose of this clinical trial was to describe two translatory non-thrust mobilization techniques and evaluate their effect on cervical pain, motion restriction, and whether any adverse effects were reported when applied to the C7 segment.

Methods: This trial included 30 participants with painful and restricted cervical rotation. Participants were randomly assigned to receive one of the two mobilization techniques. Active cervical rotation and pain intensity measurements were recorded pre- and post-intervention. Within group comparisons were determined using the Wilcoxon signed-rank test and between group comparisons were analyzed using the Mann-Whitney *U* test. Significance was set at $P=0.05$.

Results: Thirty participants were evaluated immediately after one of the two mobilization techniques was applied. There was a statistically significant difference (improvement) for active cervical rotation after application of the C7 facet distraction technique for both right ($P=0.022$) and left ($P=0.022$) rotation. Statistically significant improvement was also found for the C7 facet gliding technique for both right ($P=0.022$) and left rotation ($P=0.020$). Pain reduction was statistically significant for both right and left rotation after application of both techniques. Both mobilization techniques produced similar positive effects and one was not statistically superior to the other.

Discussion: A single application of both C7 mobilization techniques improved active cervical rotation, reduced perceived pain, and did not produce any AR in 30 patients with neck pain and movement limitation. These two non-thrust techniques may offer clinicians an additional safe and effective manual intervention for patients with limited and painful cervical rotation. A more robust experimental design is recommended to further examine these and similar cervical translatory mobilization techniques.

Keywords: Cervical mobilization, Cervical manipulation, Orthopedic manipulative therapy, Rotatory, Translatory, Translatory

Introduction

Background and objectives

Neck pain and movement limitation is common and is treated in outpatient clinics worldwide. In fact, it is estimated that 10.2 million Americans are treated in ambulatory care clinics annually for neck pain.¹ As it relates to speed of treatment application, thrust manipulation and non-thrust mobilization applied to the cervical spine are two different forms of conservative care intervention for neck pain. Both of these interventions have demonstrated positive immediate effects for pain and motion impairments.²⁻⁵ The therapeutic effects of cervical non-thrust mobilization

and cervical thrust manipulation appear to be most beneficial when combined with exercise, however, when one form of intervention is compared to the other, neither appears more beneficial.⁶

Cervical thrust manipulation involves the application of a high-velocity passive motion. Typically, multiple cervical motion segments are moved if the technique is applied with a longer lever arm by using manual contacts on the patient's head. Often, the passive motion is rotational (rotatory) in nature and, when applied in that way, thrust manipulation is not without controversy.^{7,8} Studies have reported that rotatory thrust manipulation may worsen pre-existing disk herniations,⁹ cause disk herniation resulting in both radiculopathy and myelopathy,¹⁰ and in patients with cervical spondylosis, exacerbate radiculopathic,

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and myelopathic disturbances.^{11,12} Other studies have reported that this form of manipulation may be an independent risk factor for vertebral artery dissection¹³ and a potential cause of stroke¹⁴ or internal jugular vein thrombosis.¹⁵ Further, osteophytic changes can compress and alter the anatomical configuration of the vertebral artery in the lower cervical transverse foramina beginning at the artery's C6 point of entrance. In addition, osteophytic compression may result in arterial wall injury during thrust rotatory manipulation of the lower cervical segments.¹⁶

In light of these concerns related to cervical rotatory thrust manipulation, there are trends in the literature that reflect a reduction in its use and the application of thrust manipulation elsewhere in the spine in cases of cervical pain and motion impairment.¹⁷ For example, Carlesso and Rivett¹⁸ surveyed 20 current IFOMPT member organizations (MO) and five registered interest groups (RIG) in Australia. The researchers found that 70% of the MO and RIG have modified their teaching in a way that now limits the amount of cervical rotation used during manual intervention.

The literature supports that cervical thrust manipulation with a rotatory component is at least controversial if not potentially dangerous⁷⁻¹⁶ and that manual intervention applied to adjacent motion segments below the entrance of the vertebral artery may not only have short term benefit to our patients, but may also be safer.^{17,19,20} Given this, and considering the work of Norlander *et al.*,^{21,22} who found that reduced mobility at the cervical-thoracic junction was a risk factor for neck pain, and Ozer *et al.*,²³ who noted that disk herniations are very rare at the C7 segment, the objective for this clinical trial was formulated. We sought to compare and explain two, seated translatory non-thrust cervical mobilization techniques and report their effect, in terms of the incidence of adverse reaction (AR), changes in cervical active rotation, and changes in pain perception at the end of available cervical rotation.

Method

Participants

Following receipt of the Institutional Review Board approval at Oakland University and registration with the Australian New Zealand Clinical Trials Registry, ACTRN, 12614000143628 participants were identified. Participants were included in this trial if their

neck pain was reported as two or greater on the numeric pain rating scale (NPRS), pain was reported at the end range of both left and right active cervical rotation, and active cervical rotation was restricted in both directions when examined using the CROM.²⁴⁻²⁶ Participants were screened for and excluded if they presented with any absolute contraindication to mobilization such as acute fractures, dislocations, ligamentous ruptures, instability, infection, tumors, acute myelopathy, acute soft tissue injury, osteoporosis, ankylosing spondylitis, rheumatoid arthritis, vascular disease, vertebral artery abnormalities, connective tissue disease, and anticoagulant therapy.^{27,28} A total of 30 patients, 17 female and 13 male, with a mean age of 58.37 years and a diagnosis of cervicgia, cervical osteoarthritis, cervical radiculitis, or cervical spondylosis were referred to an outpatient clinic and recruited into the trial. There was very little variance between the two groups of participants in terms of age, body weight, and number of days onset since their most recent flare up of cervical pain (Table 1). Further, no participant varied in terms of his/her resting pain intensity meaning that no one complained of cervical pain when upright and the head was in mid-position. Pain was only experienced at the end range of the patient's available active cervical rotation in both directions. Of the 30 participants, 26 were over age 50 (12 in the facet glide group, and 14 in the facet distraction group). The variation in total range of cervical rotation was 64–142°, and the variation in reported NPRS values at end range cervical rotation was 2–8 on the 0–10 scale.

Participants were first considered for recruitment during the initial physical therapy examination. The treating clinician examined each potential participant to confirm symptomatic cervical rotation impairment. If painful and restricted cervical rotation was found, written and oral information about the study was supplied by the clinician. The same clinician (therefore no blinding) performed the mobilization techniques, and recorded both pain intensity level and CROM measurements before and after technique application. If there were no questions and the participant agreed, a written informed consent was signed. Using a coin toss, the first participant was assigned to the facet joint gliding mobilization group. The group assignment was alternated after that. Confidentiality was maintained through the use of number codes for each participant's data.

Table 1 Mean (SD) of patient demographics

	Facet joint glide mobilization group	Facet joint distraction mobilization group
Age	59.40 (15.61)	57.33 (15.53)
Body weight	172.20 (44.34)	160.26 (20.77)
Number of days onset	45.26 (27.38)	39.80 (20.77)
Gender	6 male, 8 female	7 male, 9 female

Figure 1 Non-thrust C7 facet joint gliding mobilization. The T1 segment is manually stabilized in left rotation by pressing the left shoulder girdle in a posterior direction. Bilateral translatable movements are applied to the lamina and inferior facets of the C7 segment in the direction of right rotation.

Outcomes

Four variables were measured in this trial: active right rotation, active left rotation, cervical pain intensity level at end range right and left cervical rotation, and number of AR produced during or immediately post mobilization. Active range of motion (AROM) was measured using a CROM. The CROM has been found to have excellent reliability with an intra-class correlation coefficient of 0.95 for left rotation and 0.92 for right rotation.²⁶ The standard error of measurement for the CROM has been reported to range from 1.6° to 2.8°. The values for the minimal detectable change (MDC) ranged from 3.6° to 6.5°.²⁸ Active right cervical rotation was measured immediately before and immediately after a single intervention with either the C7 facet joint gliding or the C7 facet joint distraction technique. Self-report of cervical pain intensity using the 0–10 NPRS was recorded at the end of available active right rotation both immediately before and after application of one of the two mobilization techniques. The NPRS has moderate reliability with an ICC of 0.76.²⁹ This same measurement process was then followed for left cervical rotation. During and at the conclusion of technique

Figure 2 Non-thrust facet joint distraction mobilization: the clinician uses his left hand to separate (distract) the right inferior facet of C7 away from the superior facet of T1. The clinician uses his right hand to maintain a ventral and medial pressure against the lamina and inferior facet of C7. This compresses the inferior facet of C7 against the superior facet of T1. This will shift the axis of movement to the left, which will facilitate greater motion (facet distraction) on the right side of the C7 segment. Manual stabilization of the T1 segment occurs by using the right lower extremity to passively press the left shoulder girdle and clavicle in a posterior direction, which rotates the T1 segment in the opposite direction of the intended mobilization.

application, each participant was asked to report if he/she experienced any feeling of stiffness, discomfort, or other abnormal or unpleasant sensation. This ended the participant's involvement in the study and additional therapeutic interventions could be applied as indicated.

Interventions

This trial compared two non-thrust translatable mobilization techniques.³⁰ The passive non-thrust movements were directed parallel to (facet joint gliding) or at a right angle to (facet joint distraction) the joint surfaces of the C7 segment.³¹ The facet joint gliding technique incorporates a passive upward (ventral/cranial) and a passive downward (dorsal/caudal) motion to the laminae/inferior facets of the C7 vertebrae. This results in rotation of C7 on T1 in the direction of the caudally directed hand. These two passive translatable movements allow the clinician to carefully and in a graded fashion turn the C7 vertebrae

into either right or left rotation on a stabilized T1 motion segment (treatment for restricted right rotation is demonstrated in Fig. 1). Stabilization below C7 is achieved by the uppermost portion of the clinician's tibia. The clinician's right tibia is used to press the patient's left shoulder girdle, and in particular, the left clavicle in a posterior direction (Fig. 1). Pressing the left shoulder girdle and clavicle in a posterior direction will passively move the left first rib and T1 vertebrae into a left rotated position. As a result, the T1 segment is stabilized in left rotation while the C7 segment is mobilized into right rotation. This form of manual stabilization allows for more specific stretching of the soft tissue structures at the C7/T1 motion segment.

The facet distraction technique also incorporates a graded translatory movement that is applied to the anterior aspect of the C7 transverse process by the clinician's left hand, as shown in (Fig. 2). This procedure will separate (distract) the inferior facet of C7 away from the superior facet of T1 and therefore facilitate facet joint capsular stretching. As this passive mobilization is occurring, the clinician uses his right hand (Fig. 2) to maintain a ventral and medial pressure against the lamina and inferior facet of C7. This compresses the inferior facet of C7 against the superior facet of T1. This will theoretically shift the axis of movement to the left which will facilitate greater motion (facet distraction) on the right side of the C7 segment.³⁰ Manual stabilization of the T1 segment occurs by using the right lower extremity to passively press the left shoulder girdle and clavicle in a posterior direction, which rotates the T1 segment in the opposite direction, to the left in this case, of the intended direction of mobilization. Facet distraction mobilization applied to the right side is used in cases of restricted right cervical rotation. (See force vectors in Fig. 2).³⁰ In this study, a single intervention consisted of three consecutive, 7-second, grade III, non-thrust facet glide or facet distraction mobilizations.³¹

Data analysis

The effect of each non-thrust mobilization technique on ROM and pain level was analyzed using inferential statistics including: the Wilcoxon signed-rank test for within group comparisons and the Mann-Whitney *U* test for between group comparisons. The *P*-value was set at *P*=0.05. Data analysis was performed using SPSS 11.5.

Results

Table 1 describes the participants for each group. Pre-mobilization and post-mobilization range of motion values as well as the number of AR post manipulation (none) is shown in Table 2. The data found in Table 3 list the *P*-values and note the changes in the reported NPRS value at end range cervical rotation after the application of both techniques. A Wilcoxon Signed-Rank test was used to analyze within group comparisons for changes in the range of motion and reported pain intensity following treatment application. Based on this analysis, using the Mann-Whitney rank sum test, no significant difference was found between these two manual interventions for rotation (*P*=0.304) and NPRS (*P*=0.739) intensity level after treatment application.

Discussion

The 30 participants treated in this trial were representative of patients commonly referred to an outpatient physical therapy setting with both pain and movement impairment in the cervical spine. Table 2 shows a summary of the *P*-values. All values exceeded the 0.05 level of significance indicating post-mobilization improvement (increase) in active cervical rotation in both directions. This active motion increase was, in total, approximately 10° for each participant. This is not a dramatic increase in cervical rotation, but at the same time, the researchers do not believe that either mobilization is a 'stand alone' technique. These two techniques should be applied in conjunction with other manual and exercise interventions during the provision of a comprehensive treatment session.⁶ In addition; the researchers recommend the use of seated cervical mobilization when the patient presentation is more 'stiffness dominant' as compared to 'pain dominant'. Simply, patients who experience less cervical discomfort in the supine position, as compared to being upright should be treated in that position. As stated earlier, no participant was experiencing cervical pain when upright and his/her head was in mid-line. Pain was only experienced at the end of a limited range of movement. Also, the seated position allows for quick visual re-evaluation of active cervical rotation post-mobilization, and efficient re-application of the CROM device.

Table 2 Mean (SD) for cervical rotation

Mobilization technique	Pre-mobilization RR (°)	Post-mobilization RR (°)	<i>P</i> -value post-mobilization RR	Pre-mobilization LR (°)	Post-mobilization LR (°)	<i>P</i> -value post-mobilization LR	AR post manipulation
Facet gliding group	50.38 (9.96)	55.69 (11.06)	0.022*	51.38 (10.35)	56.38 (11.00)	0.022*	None
Facet distraction group	49.62 (9.80)	54.72 (10.12)	0.022*	50.83 (11.75)	55.86 (11.87)	0.020*	None

RR: right rotation; LR: left rotation; AR: adverse reaction.

*Statistical significance, *P* was set at *P*=0.05, Wilcoxon signed rank-test.

Table 3 shows a statistically significant reduction of verbally described pain intensity at the end range of active cervical rotation. Previous studies, which have focused on manipulative intervention applied to the upper thoracic segments, also reported improvement in cervical pain. Krauss *et al.*¹⁹ reported a 1.5 reduction in reported pain intensity using the faces pain scale (FPS). Similarly, Cleland *et al.*,²⁰ demonstrated a 15.5 mm reduction in pain on the visual analog scale (VAS) after manipulation of the restricted upper thoracic segments. In a more recent study by Cleland *et al.*,²⁹ researchers determined the minimal clinical important difference (MCID), specifically for neck pain. They found that a change (decrease) of 1.3 points on the NPRS was the MCID for neck pain. Based on the findings by Cleland *et al.*,²⁹ the change in pain perception at end range left rotation meets the MCID, indicating clinical significance. The value for end range right rotation was close to, but did not exceed, an MCID of 1.3. If the NPRS value reported immediately post mobilization was taken at the recorded pre-mobilization point of cervical rotation, not the additional (improved) point in the range of movement, the improvement (reduction) in the reported NPRS values of 1.21 and 1.20 immediately post mobilization would likely have been greater. Also, regarding the improvement in pain intensity, in clinical practice, these two techniques should not be applied in isolation, but rather as part of a comprehensive session of manual intervention. If applied in that way, the improvement in recorded NPRS values may be greater.

When considering the issues regarding AR associated with cervical manipulation, no participant in this study reported discomfort, or any other form of minor reaction or injury, in relation to the application of the two mobilization techniques examined (Table 2). One could speculate that maintaining a mid-line position for the supra-adjacent C0–C6 segments, a feature of both techniques, and applying these mobilizations below the entrance of the vertebral artery would likely contribute to enhanced safety and minimize the chance for AR.^{7–16}

The incidence of AR and the biomechanics of the manipulative technique that may have caused harm to patients with neck pain and movement impairment is difficult to assess, since only reported cases can be

studied.^{9,16,32} Thrust manipulation with a fast rotatory component occurring through multiple lower cervical segments may be the factor most associated with minor flare ups in cervical discomfort and more serious complications, such as causing disk herniation and producing radiculomedullary irritation because of pre-existing disk herniation or arterial injury.^{9–16,33–35} It is possible that application of manual intervention to the C7 segment, below the entrance of the vertebral artery and where the incidence of disk herniation is very low²³ may reduce the chance of AR. It has been proposed that rotatory thrust manipulation contributes to the rapid recovery of acute and sub-acute cervical pain disorders and promotes a brief analgesic effect after its application.³⁶ While that may be the case, non-thrust mobilization has also been shown to promote a brief neurophysiological effect.³⁷ Further, in a study consisting of 182 participants with nonspecific neck pain of less than 3 months in duration, Leaver *et al.*³⁸ showed that cervical thrust manipulation did not promote a faster recovery from an episode of neck pain when compared to non-thrust mobilization.

Unlike thrust manipulation, non-thrust mobilizations, similar to the two techniques used in this trial, involves the use of slowly applied oscillatory or graded motions that are under the patient's control to stop through the activation of muscle guarding, or by verbal interaction with the clinician, should an increase in symptoms such as pain, dizziness, or other neurological sensations, like tingling or numbness, be felt.^{39,40} Speed of technique application, positioning of the mid and lower cervical segments closer to mid-line in cases of spondylotic and degenerative cervical disk disease,⁴¹ and passive force application, which incorporates translatory motion may be key components of manual intervention that promotes safety and minimizes AR.^{39–41}

Limitations

A quasi-randomized controlled trial is a useful design for testing the particular outcome measures of interest, namely, the immediate effects of two different manual interventions on a patient population. Unfortunately, there are limitations associated with this trial that should be corrected in a robust experimental design. First, the researcher was not blinded and performed all interventions and subsequent measurements. Therefore, the potential for

Table 3 Mean and P-values for the numeric pain rating scale (NPRS) pre- and post-mobilization

Mobilization technique	NPRS at end range RR (°) pre-mobilization	NPRS at end range RR (°) post-manipulation	P-value for RR	NPRS at end range LR (°) pre-mobilization	NPRS at end range LR (°) post-mobilization	P-value for LR
Facet glide	2.69	1.48	0.018*	2.79	1.28	0.022*
Facet distraction	2.48	1.28	0.020*	2.66	1.14	0.020*

RR: right rotation; LR: left rotation.

*Statistical significance, P was set at $P=0.05$, Wilcoxon signed rank-test.

examiner bias regarding the use of these techniques cannot be ruled out. Second, there is a clear challenge in terms of study reproducibility given the training required for correct and consistent application of these two mobilization techniques. Third, patients who receive hands-on intervention are potentially at risk for a placebo effect and subsequent psychological implication on symptoms. This may have in part contributed to the improvement in the NPRS values post treatment application. Fourth, there were only 30 participants in this trial; a robust experimental design should look at a greater number of patients. Lastly, while participants on average gained 10° of total cervical rotation after just one application of the mobilization techniques, a portion of this recorded increase in cervical motion may have been due to measurement error when using the CROM device.^{24–26,42}

Conclusion

The two low velocity mobilization techniques that were applied to the C7 segment appear to promote improvements in cervical rotation bilaterally. They also appear to promote reduction in reported pain intensity at the end of range of these movements. No participant reported any increase in cervical or upper extremity symptoms during technique application. Given the segmental level, speed of application, mid-line positioning, and short translatory motion, the two mobilizations presented offer clinicians an additional means to address painful cervical rotation restriction as compared to long lever rotatory thrust manipulation applied through multiple lower cervical motion segments.

Disclaimer Statements

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