Applying Joint Mobilization at Different Cervical Vertebral Levels does not Influence Immediate Pain Reduction in Patients with Chronic Neck Pain: A Randomized Clinical Trial

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Spinal manipulative therapy includes techniques based on joint manipulation and mobilization, the main difference between each being the amplitude and velocity of the force applied to the vertebra¹. The term mobilization is usually associated with low-velocity rhythmic movements applied in short or large amplitudes, while manipulation involves high-velocity movements applied over small amplitudes¹. In the past, randomized clinical trials and systematic

reviews have shown the efficacy of these techniques on pain relief and function restoration in patients with both chronic and acute non-specific neck pain²⁻⁷.

In clinical settings, both mobilizations and manipulations are usually applied over the most symptomatic vertebral level. For instance, Maitland et al¹ have suggested that the selection of mobilization techniques for patients with neck pain should depend on pain localization and symptom reproduction, and

the vertebral level to be treated should be the one that most often reproduces symptoms during accessory movement testing.

However, previous studies have demonstrated that applying spinal manipulative therapy to asymptomatic areas may also result in symptom improvement⁸⁻¹⁰. A recent randomized clinical trial including 140 patients with non-specific low back pain demonstrated that when patients were submitted to mobilization techniques directed to different vertebral levels (i.e., either a symptomatic level or randomly chosen level), similar immediate effects on pain and range of movement were observed⁸. These results suggest that the efficacy of spinal manipulative therapy is not associated with the choice of vertebral level where the force is applied.

Likewise, Vicenzino et al¹⁰ demonstrated that SMT applied to the cervical spine promotes immediate hypoalgesic and sympathoexcitatory effects in patients with chronic lateral epicondylitis, suggesting stimulation of the dorsal/dorsolateral periaqueductal gray region (dPAG). The participation of a central modulatory mechanism of pain in spinal manipulative therapy¹¹⁻¹⁴ could then explain, for instance, why immediate epicondylalgia improvement would be shown as a result of cervical spine mobilization¹⁰, or why immediate pain reduc-

ABSTRACT: The aim of the present study was to compare the effects of applying joint mobilization at symptomatic and asymptomatic cervical levels in patients with chronic non-specific neck pain. Forty-eight patients aged between 18 and 65 years and presenting non-specific neck pain with a minimum duration of 3 months were recruited for the study. Included patients were randomized to one of two treatment groups: (i) control group: the most symptomatic vertebral level was mobilized; (ii) experimental group: a randomly selected vertebral level was chosen and mobilized. All patients received one treatment session. Pain intensity in resting position during the most painful active cervical movement as well as during vertebral palpation was quantified using an 11-point pain scale. Follow-up measures were taken immediately after intervention by a blinded assessor. The results showed no significant difference in pain intensity immediately after treatment between groups (symptomatic level treated vs. randomly chosen cervical vertebral level treated) during resting position, painful active movement, or vertebral palpation. Within-group comparisons showed significant pain relief after treatment during the most painful active movement as well as during vertebral palpation for both groups, but not during resting position. Significant change in immediate pain intensity during painful active movement and vertebral palpation was achieved after vertebral mobilization. However, both groups presented similar pain reductions suggesting that pain reduction due to joint mobilization is not specific to the vertebral level being mobilized.

KEYWORDS: Manual Therapy, Mobilization, Neck Pain, Randomized Clinical Trial

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tion in the lumbar spine would not depend on the lumbar vertebral level being mobilized⁸.

The aim of the present study was to compare the effect of low-velocity cervical mobilization applied to either the most symptomatic cervical vertebra or a randomly chosen cervical vertebra in subjects with non-specific neck pain.

Methods

Patients

Forty-eight individuals with non-specific neck pain presenting to a large university teaching clinic (Pontificia Universidade Católica de Minas Gerais) as well as private clinics in Belo Horizonte, Brazil were invited to participate in the study. To be included, patients needed to be between 18 and 65 years of age and present with non-specific neck pain of a minimum duration of 3 months.

Patients were excluded if they had been diagnosed with signs or symptoms of vertebral artery insufficiency, osteoporosis, tumor, infection, fracture, history of trauma; if they had a history of cervical surgery in the last 12 months; or if they were pregnant. Patients presenting with any neurological deficit, as evidenced by a positive neurological clinical examination, as well as patients who had been undergoing physiotherapy treatment in the previous 6 months were also excluded.

Procedures

Assessment

Medical history, as well as pain distribution and behavior, were assessed prior to commencing the study. A detailed physical examination was also performed on all patients. Patients were asked to quantify their pain at rest and during active neck flexion, extension, lateral flexion, rotation, and combined movements on an 11-point pain scale (0 to 10), where "0" was defined as no pain and "10" as the worst imaginable pain¹⁵. To verify the most painful vertebral level, passive accessory intervertebral movements were performed with patients lying prone. This consisted of applying pressure over

all cervical spinous processes and facet joints. Pain reproduction during the test was quantified also using the same 11-point pain scale. The Patient Specific Functional Scale was only measured at baseline to quantify the functional status of each subject¹⁶. For the Patient Specific Functional Scale, participants were required to list three activities they had trouble with as a result of their neck pain on that day and rate the degree of difficulty of each activity from 1 (unable to perform) to 10 (able to perform at pre-injury level). The scores for the three activities were summed, giving a total score that could range from 3 to 30.

Treatment Groups

Patients were randomly allocated to either a control or an experimental group, using a computer-generated allocation list. Both the assessor and the treating physiotherapists were blinded to group allocation. In the control group, treatment was targeted to the most symptomatic vertebral level, identified during the assessment process. Patients allocated to the experimental group received mobilizations applied over a randomly chosen cervical vertebral level.

A well-trained physiotherapist was responsible for applying one of the following techniques, according to Maitland et al¹: postero-anterior central vertebral pressure (PACVP), postero-anterior unilateral vertebral pressure (PAUVP), and transversal vertebral pressure (TVP). Technique selection was at the physiotherapist's own discretion, based on assessment findings. The grade of the technique as well as the rhythm and number of repetitions were performed as indicated by Maitland et al¹ to meet the patient's needs. All patients received one treatment session.

Outcomes Measures

Pain intensity was quantified at rest, during active cervical movement (flexion and extension, lateral flexion, rotation, and combined movements), and during vertebral palpation, using the 11-point pain scale. Outcome measures were assessed before and immediately after treatment.

Statistical Analysis

The sample size was calculated and determined at 48 patients (24 in each group) to find a between-group difference in pain of at least 1.5 points (11-point scale), with power established at 80% and significance level at 0.05. Linear regression was used to establish a possible association between post-treatment pain-intensity levels and treatment group. Pain intensity at baseline was the only covariate to be included in the model and was chosen *a priori*. Analysis was by intention to treat. Unstandardized regression coefficients and 95% confidence intervals were used to establish differences between groups, where the mean difference between groups would be adjusted to baseline pain intensity levels. A paired *t*-test was used to assess within-group differences. All analyses were performed using SPSS 15.

Results

Fifty-three patients with non-specific neck pain of at least 3 months duration were invited to participate. Four patients did not satisfy the inclusion criteria for this study because they presented neurological deficit suggesting radiculopathy (1), duration of pain was less than 3 months (2), or they were older than 65 (1). One patient refused to participate in the study. The 48 remaining patients were randomized into the two treatment groups: control (*n* = 24) and experimental (*n* = 24) (Figure 1).

A descriptive analysis of each group is presented in Table 1. The frequencies regarding symptom distribution, most painful active movement, and symptomatic vertebral level for each group are presented in Table 2.

Pain at Resting Position

The results demonstrated no significant difference in pain intensity at resting position after treatment in the control group (*p* = 0.99) or experimental group (*p* = 0.29). Likewise, no significant between-group differences in mean pain intensity levels were observed, when adjusted for baseline levels (adjusted mean

FIGURE 1. Recruitment flowchart

TABLE 1. Descriptive patient data

Mean	Control Group (n=24)	Experimental Group (n=24)
Age		
Mean (SD)	32.6 (13.0)	35.6 (13.7)
Female		
N (%)	20 (41.7)	15 (62.5)
Cervicogenic headache incidence		
N (%)	14 (58.3)	11 (45.8)
PSFS		
Mean (SD)	17.7 (5.6)	16.0 (5.2)

SD = standard deviation; PSFS = Patient Specific Functional Scale; N = number; Control group: symptomatic vertebral level; Experimental group: random cervical vertebral level

difference -0.52 , 95% CI: -1.87 to 0.83 , $p = 0.44$).

Pain During Most Painful Active Movement

A significant within-group difference in pain intensity during the most painful active movement was observed in both control and experimental group ($p < 0.001$; Table 3). No differences between groups were observed (adjusted mean difference -0.13 ; 95% CI: -1.63 to 1.38 , $p = 0.87$; Table 3).

Pain During Vertebral Palpation

Likewise, a significant difference was found between pre- and post-treatment values for both control and experimen-

tal groups ($p < 0.001$; Table 3), but no between-group difference was observed for pain reduction during vertebral palpation (adjusted mean difference -0.16 ; 95% CI: -1.31 to 0.99 , $p = 0.78$; Table 3).

Discussion

The results of the present study showed no significant difference in pain inten-

sity immediately after treatment between groups (symptomatic level treated vs. randomly chosen level treated) in patients with chronic non-specific neck pain. Significant pain relief was noticed post-treatment during the most painful active movement and vertebral palpation for both groups. These findings suggest that patients with chronic neck pain may experience immediate pain relief

during movement and vertebral palpation, irrespective of which cervical vertebral level is being mobilized.

Previous studies corroborate with our findings, demonstrating that SMT interventions can result in significant pain improvements even when not directed to symptomatic area^{8,10,17-19}. Chiradejnant et al⁸ have shown that applying joint mobilizations to different

TABLE 2. Frequency of symptom location, most painful active movement, and most symptomatic vertebral level in each treatment group

Variables		Control Group (n = 24)	Experimental Group (n = 24)	Total (n = 48)
Symptom location	Cervical spine only	3	2	5
	Cervical spine and upper limbs	21	22	43
Most painful movement	Flexion	4	6	10
	Extension	6	3	9
	Right lateral flexion	1	1	2
	Left lateral flexion	3	7	10
	Right rotation	0	2	2
	Left rotation	1	0	1
	Extension and rotation	4	2	6
	Flexion and rotation	2	1	3
	Flexion and lateral flexion	1	1	2
	Retraction	0	1	1
	Protusion	2	0	2
Symptomatic vertebral level	(C1-C3)	11	6	17
	(C4-C7)	13	18	31

TABLE 3. Mean, standard deviation (SD), difference between pre- and post-treatment for each group, mean for difference among the groups

Variable	Control Group Mean (SD) (n = 24)	Experimental Group Mean (SD) (n = 24)	Adjusted mean difference between groups (95% IC)	P value
Pain at resting position				
Pre-treatment	2.87 (2.49)	2.91 (2.28)		
Post-treatment	2.87 (2.93)	2.37 (2.33)	$-0.52 (-1.87 \text{ to } 0.83)$	0.44
Pre- and post-treatment difference	0 (2.57)	0.54 (2.48)		
Pain during most painful movement				
Pre-treatment	6.2 (2.1)	6.04 (2.05)		
Post-treatment	3.58 (3.11)	3.37 (2.35)	$-0.13 (-1.63 \text{ to } 1.38)$	0.87
Pre- and post-treatment difference	2.62 (2.34)*	2.67 (3.14)*		
Pain during vertebral palpation				
Pre-treatment	7.62 (1.37)	7.29 (1.85)		
Post-treatment	5.25 (2.11)	4.87 (2.29)	$-0.16 (-1.31 \text{ to } 0.99)$	0.78
Pre- and post-treatment difference	2.37 (1.84)*	2.42 (2.20)*		

* $P < 0.001$; Positive values for pre-post treatment differences indicate pain relief

lumbar vertebral levels does not influence the effects on pain reduction and range of motion in patients with non-specific low back pain. Cleland et al⁹ observed that thoracic spine manipulation results in immediate improvements of neck pain when compared to placebo, suggesting that thoracic spine manipulation may be a reasonable alternative or perhaps a supplement to manual therapy interventions directed to the cervical spine. Vicenzino et al¹⁰ have demonstrated that a cervical contralateral lateral glide produces significant improvements in pressure pain threshold, pain-free grip strength, and pain scores in patients with lateral epicondylalgia.

A possible explanation for these findings might rely on the mechanisms behind immediate analgesic effects associated with spinal mobilizations. Recent studies have shown that spinal manipulation can activate an endogenous, descending, pain-inhibitory system, resulting not only in manipulation-induced hypoalgesia but also in sympatho-excitation and motor effects^{7,11,19-20}. Thus, the participation of a central modulatory pain mechanism could explain why immediate pain reduction would not be associated with the vertebral level being mobilized.

Likewise, previous studies have shown that mechanical stimuli on spinal vertebrae produce vertebral motions not only at the segmental contact but also in the adjacent vertebral segments in ovine²¹ and human²² spines. Therefore, by mobilizing any cervical vertebra, motion would be produced in other cervical segments, one of which could be the symptomatic segment. Whether this motion propagation would be enough to be responsible for clinical improvement still has to be elucidated.

A third feasible explanation for immediate decreases in pain, in particular pain during the most symptomatic active movement, could rely on changes in muscle activity following spinal mobilization. Ferreira et al²³ have previously demonstrated that joint mobilization can produce immediate significant changes in the functional activity of trunk muscles in patients with chronic low back pain. These immediate changes

in muscle function could reflect either changes in motoneuron excitability following spinal mobilization or changes in the output from higher centers²³. Posteroanterior spinal mobilizations also produce decreases in EMG activity of superficial neck flexor muscle activity¹. Immediate motor changes could, therefore, result in less painful active movements following spinal mobilizations.

Two study limitations require consideration. First, the population included in the study presented with low levels of pain at rest (mean: 2.87 for each group). This explains why our results did not demonstrate any within-group effect of joint mobilization on pain intensity levels at rest, since baseline values were below the minimum detectable change reported for neck pain numerical ratings²⁴. These findings need to be replicated in a more symptomatic population. Second, the interpretation of our results should be limited to immediate effects of neck mobilizations, since no follow-up assessments were performed in this study. The long-term effect of applying spinal mobilizations to randomly selected cervical vertebral levels is still unclear.

Conclusion

Cervical joint mobilizations produce immediate pain reduction during movement and palpation in patients with chronic neck pain. However, these effects are not influenced by the cervical segment being mobilized. Future studies should aim at establishing the long-term effects of applying joint mobilization at different vertebral levels.

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