The Effect of an Analgesic Mobilization Technique When Applied at Symptomatic or Asymptomatic Levels of the Cervical Spine in Subjects with Neck Pain: A Randomized Controlled Trial

JOCHEN SCHOMACHER, PT, OMT, MCMK, DPT, BSc, MSc Phys

Many patients with different medical diagnoses associated with neck pain seek help from a physiotherapist¹. Manual therapy techniques, including mobilization, are often used to treat selected neck conditions. Selection of a specific mobilization technique during clinical decision-making depends largely on four exploratory findings. First, the manual therapist must determine whether mobilization or stabilization/motor control is indicated for the patient. Second, an assessment of a technique type (specific or general) is useful to further orient the proper application of treatment. Third, treatment dosage is assessed to define the ideal intensity to alleviate pain. Last, proper location of ap-

plication (e.g., appropriate segment) is a notable consideration for most clinicians. Most manual therapists believe that treatment should be applied to the most symptomatic level²⁻⁴, therefore, the examiner targets the segment that has a high correlation between the concordant patient's musculoskeletal signs (i.e., altered mobility, pathological end feel and tissue alteration) that result in changes in symptoms such as pain². Clinical tests used to identify the patient's musculoskeletal signs are called *symptom localization tests*.

A literature search revealed 9 studies concerning symptom localization tests in the cervical spine^{5,6}. Five examined clinical application tests associated with

movement and reported; 1) a 100% agreement with the accepted gold standard of local anaesthesia⁷; 2) a 75% correlation between the manual symptom localization test and an increased bone density in scintigraphy SPECT⁸; 3) about 85% agreement between pain and a rotation movement in the segment C1-C2 while keeping the cervical spine below C2 in full flexion⁹; 4) a highly variable and unacceptable reproducibility of the tests between two physiotherapists¹⁰; and 5) no difference in the effect of a manipulation in the localized segment or in another randomly assigned cervical segment¹¹. Four studies examined the reliability of palpation to find the most painful segment. Two showed good agreement between two examiners^{12,13}, and another two found poor agreement between several examiners^{14,15}. Differences in research designs and techniques for the tests do not allow any pooling of these results; consequently, no clear conclusions on validity and reliability of symptom localization tests can be drawn.

While it is logical to assume that a manual procedure such as a stretch or a mobilization should be applied specifically to a hypomobile joint, muscle, or nerve, findings associated with a painful segment may provide different results. In the lumbar spine, Chiradejnant et al⁴ found that 2 minutes of mobilization at the most symptomatic or dysfunctional segment was more effective for pain relief than in a randomly selected segment.

ABSTRACT: The purpose of this single-blinded, randomized controlled trial was to compare the effects of a manual treatment technique on neck pain and movement sensation when applied in different segments of the cervical spine. Consecutive patients with neck pain (n=126) were recruited and randomly allocated to two groups (A or B). Group A received a single 4-minute pain-alleviating traction at the most symptomatic zygapophyseal joint of the cervical segment, where movement was correlated with pain. Group B received the same treatment 3 segments away from the concordant segment. Pain intensity and sensation of movement were assessed with a numeric rating scale (NRS). Statistical analysis included a *t*-test for paired and unpaired samples. Pre- and post-test findings demonstrated significant improvements in both types of mobilization although there was no significant difference between the two groups. Similar results have been reported in the literature for cervical manipulation. The findings of this study question the necessity of precise symptom localization tests for a pain treatment. However, limitations of the study prevent generalization of these results.

KEYWORDS: Mobilization, Randomized Controlled Trial, Specificity of Treatment, Symptom Localization Tests, Traction

Freelance Instructor of Physiotherapy, Küssnacht, ZH

Address all correspondence and requests for reprints to: Jochen Schomacher, Jochen-Schomacher@web.de

However, the reported mean difference was <0.5 on an 11-point numeric rating scale (NRS); thus, the clinical relevance of the finding is questionable. A clinically relevant reduction in pain intensity generally requires higher reductions on a NRS than 0.5 points¹⁶.

Haas et al¹⁰ found no difference after manipulation in a localized or randomly assigned cervical segment. The distribution of manipulated segments, however, was very similar in both groups, which may have contributed to the comparable effect findings. No similar studies have been found for cervical mobilization techniques, which are considered to involve less risk than manipulation^{17,18}. Subsequently, the purpose of this study was to evaluate the immediate effects (pain reduction and sensation of movement) of analgesic mobilization techniques for patients with neck pain when applied at symptomatic levels versus asymptomatic levels. Investigation of the necessity of symptom localization for pain-alleviating mobilization may assist in improving the efficacy of physiotherapy and create a common basis for a consensus between different manual therapy approaches.

Material and Methods

Study Design

The study was a prospective, randomized controlled trial. Ethical approval was obtained by the Department of Medicine of the Philipps-University, Marburg, Germany.

Participants

Between February 22, 2007 and April 2, 2007, potential participants were consecutively recruited for the study by therapist referral and/or advertisement in 3 arbitrarily chosen private physiotherapy practices, 3 hospitals, 1 physiotherapy school, and postgraduate courses of manual therapy. A sample size of 63 patients per group was calculated *a priori* to detect a 1-point difference on the 11-point NRS between groups with 80% power for a 2-sided *t*-test set at the 0.05 level of significance. The pain reduction of 1/11 NRS was

chosen as clinically relevant according to Haas et al¹⁰ and Briggs and Clos¹⁸.

The primary inclusion criterion was neck pain with or without irradiation into the arm(s) that changed with movements between C2 and C7 (the techniques used for symptom localization tests and treatment were specific for this region). No medical diagnosis was necessary and participants had to be over 17 years old. Patients who were involved in a traumatic injury required confirmation of stability during the examination movements by an attending medical physician. Participants had to be able to sit and to lie down, demonstrate active and passive movements, and to read and to understand the study information and questionnaire. Once met, the participants were asked to sign the informed consent components of the ethics board.

Exclusion criteria involved all conditions in which active and passive movements could harm the patients, findings associated with the presence of red flags for trauma (whether or not they were screened by a medical physician), and evidence of irritable nerve compression and acute inflammation¹⁹. Patients were excluded when pain did not reduce 1–2 minutes after provocation/aggravation to an acceptable level for the patient during questioning using self-report questionnaire and interview. In addition, before initiation of intervention, testing was performed to assess the function of vertebral artery and the stability of the upper cervical spine²⁰ according to the Australian guidelines for manipulation²¹. At present, these tests have demonstrated questionable validity²², predictive value²³, sensitivity, and specificity^{24,25}. Patients with positive findings were excluded from the study.

Study Intervention

The purpose of this study was to evaluate the effect of analgesic mobilization techniques for patients with neck pain when applied at symptomatic levels versus asymptomatic levels. Subsequently, two important clinical elements were necessary. First, concordant pain with movement was necessary to isolate mechanical findings. Second, segmental testing

was necessary to isolate the concordant level of the problem.

After demonstration of the painful movements, the safest motion that produced symptoms with the most minimal effort was chosen for symptom localization. In most cases, extension is the most prevalent painful movement²⁶ and the most efficient for symptom localization tests. Because rotation has been associated with some report of complications, rotation was routinely used as the last selection²⁷. Consequently, when participants exhibited more than one painful movement, they were tested first with extension, then with side-bending, and finally with rotation. Flexion was selected as the last option because of technical difficulties in performing the symptom localization test.

For determination of the spinal level, the spinous process of C2 was taken as a reference point. The physiotherapist researcher's index finger was placed horizontally on C2 followed by the other fingers below that level. The breadth of each finger was considered approximately one spinal level. This may be insufficiently precise for exact localization of spinal levels but was a guarantee to keep a consistent distance between the located segment and the one at 3 segments (3 fingers distance).

When more than one segment had been painful, the most painful level was selected for this study. The procedure was performed as follows: While sitting, the patient actively moved in the painful direction (found previously) until the initiation of symptoms (Figure 1). In this position, the physiotherapist-researcher applied passive segmental movements to find the segment, which was correlated with pain (Figure 2). The dorsal hand fixated the caudal vertebra of the segment with the thumb and index finger on the vertebral arch. The little finger of the ventral hand was placed on the opposite site of the vertebral arch of the cranial vertebra. The palm of this hand held the head against the therapist's chest. The final step involved movement of the cranial vertebrae and the head as a unit into extension.

After identification of the painful direction and the concordant segment,

participants were randomly allocated to one of two groups (A or B). Group A received treatment at the concordant segment, and Group B received treatment 3 levels below or above the concordant segment. Treatment for this study involved an intermittent translatory traction at the zygapophyseal joint between C2 and C7, fixating the cranial vertebrae while moving the caudal vertebrae³. The direction of the translatory movement was perpendicular to the treatment plane, which is an imaginary plane placed on the concave joint surface³ (Figure 3).

The applied force was a Kaltenborn's grade II, in which only minimal resistance is felt during motion and movement does not exceed the first perceivable stop³. The frequency of the intermittent traction was arbitrarily fixed at approximately 6–7/Hz and changed as needed at 30 seconds, based on the self-report of the patient. The technique was applied for 4 minutes, a typical duration of a trial treatment for pain used in clinical manual therapy. The manual therapy procedure was performed by one physiotherapist-researcher with 20 years of experience and formal, specialized training in musculoskeletal treatment and orthopaedic manual therapy.

Participants were not informed as to which treatment group they had been allocated to. Upon completion of the manual procedure and while isolated from the manual therapist, each participant completed the NRS for pain. Some, including many elderly patients, required assistance completing the NRS. The researcher who conducted the treatment was not blinded to the treatment level, and spontaneous comments were made by the participants throughout the study. Blinding for data analysis was not performed.

Outcomes

The primary outcome was neck pain intensity evaluated with an 11-point NRS prior to and immediately after the treatment. The secondary outcome was the sensation of movement in the neck evaluated with an NRS similar to pain evaluation.

Data Collection and Statistical Analysis

Data were collected on an anonymous form sheet that was enclosed in an opaque envelope. The envelopes were opened only after all data in this study

had been collected. Data were transferred into a personal computer notebook (IBM R40) with the software Microsoft Excel 2003. Data associated with age, sex, most painful side, pain duration, time between questionnaire and study intervention, results of examination for risks, treatment group, and NRS values for pain intensity and sensation of movement were also collected and tabulated.

NRS values were analyzed for the treatment effect within each group with a paired *t*-test (differences before and after treatment) and for the differences of treatment effects between group A and B with an unpaired *t*-test. The *t*-test normal distribution of data was checked by a Kolmogorov-Smirnow-test for age and pre-test NRS values. Level of significance was fixed at $\alpha = 0.05$. Statistical analysis was performed using SPSS 12.0G for Windows (Version 12.0.1).

Results

Participant Descriptive Statistics

Of the 128 participants with neck pain who fulfilled the inclusion and exclusion criteria, one participant in each group had to be excluded after less than 1 min-

Fig. 1 a: Movement in all cervical segments could be correlated with pain.

Fig. 1 b: Movement between C2 and C3 cannot be correlated with pain.

Fig. 1 c: Movement between C3 and C4 is correlated with pain.

FIGURE 1. Schematic representation of symptom localization tests with movements

Fig. 2a. Active extension of the neck is the pain-provoking motion.

Fig. 2b. Extension with an emphasis of movement at C2.

Fig. 2c. Extension with an emphasis of movement at C3.

Fig. 2d. Extension with an emphasis of movement at C4.

Fig. 2e. Extension with an emphasis of movement at C5 or C6.

Fig. 2f. Extension with an emphasis of movement at C7.

FIGURE 2. Examples of symptom localization tests when extension of the neck was the painful movement

Fig. 3a. Direction of traction perpendicular to the treatment plane in segment C2-C3.

Fig. 3b. Traction in the right zygoapophyseal joint of C2-C3.

Fig. 3c. The same traction seen from above.

FIGURE 3. The treatment procedure used in the study: traction of the zygoapophyseal joint

ute of treatment because of allodynia. Randomization allocated 59 participants into group A (treatment in the located segment) and 67 into group B (treatment at 3 segments away from the located one) (Figure 4). The mean ages of the two groups [group A, 45.9 years (SD 16.8); group B, 53.2 years (SD 17.4)] were significantly different ($p=0.02$).

The mean pain duration for group A was 74.7 months (SD 79.3), and for group B 75.9 months (SD 88.1). Mean pain intensity in the questionnaire was 3.4 (SD 1.6) for group A and 3.7 (SD 1.9) for group B. Mean NRS values for sensation of movement in the questionnaire were 3.9 (SD 1.7) for group A, and 4.2 (SD 1.8) for group B. The painful side (right,

left, middle) and the located segments were equally distributed between the two groups.

Analytic Statistics Regarding Participants

The Kolmogorow-Smirnow test revealed a normal distribution for pre-test

FIGURE 4. Study flowchart

TABLE 1. NRS values before and after treatment

	Group A (N=59) mobilization at concordant level Mean (SD) 95% CI	Group B (N=67) mobilization at 3 levels above or below Mean (SD) 95% CI
NRS values for pain intensity before treatment	3.1 (1.6) 2.7–3.4	3.7 (1.8) 3.3–4.1
NRS values for pain intensity after treatment	1.8 (1.4) 1.4–2.1	2.0 (1.6) 1.7–2.5
NRS values for sensation of movement before treatment	3.8 (1.6) 3.4–4.3	4.3 (1.9) 3.9–4.8
NRS values for sensation of movement after treatment	2.0 (1.3) 1.7–2.3	2.1 (1.7) 1.7–2.5

TABLE 2. Differences in change scores of NRS for pain intensity and sensation of movement between group A and group B

	Group A (N=59) mobilization at concordant level Mean (SD) 95% CI	Group B (N=67) mobilization at 3 levels above or below Mean (SD) 95% CI	P value
Change scores for NRS values for pain intensity	1.3 (1.2) 0.98–1.6	1.7 (1.5) 1.3–2.0	0.12
Change scores for NRS values for sensation of movement	1.9 (1.4) 1.5–2.2	2.2 (1.6) 1.9–2.6	0.15

NRS values in all groups. An unpaired *t*-test showed no difference between the groups regarding the NRS values from the questionnaire.

NRS values before and after treatment are shown in Table 1 for both groups. The differences before and after treatment within each group were significantly different ($p < 0.01$). Differences in change scores of NRS for pain intensity and sensation of movement between group A and group B are shown in Table 2. The *t*-test revealed no significant difference between groups for the change scores for NRS values for pain intensity ($p=0.12$) and for sensation of movement ($p=0.15$).

Discussion

The results of this study exhibit positive effects on pain and movement sensation directly after a 4-minute treatment with movements in the cervical spine when applied at a concordant segment, in which movement is correlated with pain as well as at a distance of 3 segments from the concordant segment. Both pain and movement sensation improved in both conditions, and no statistical significance was found between the two

groups. The study is unique in that it is the first to report comparative findings between a traction-based mobilization procedure in patients with report of neck pain and to my knowledge it is the first to investigate perception of movement after treatment.

These findings are similar to those reported by Haas et al¹¹, who also investigated manual therapy techniques at different levels of the cervical spine. The authors showed pain reduction with manipulation performed at a segment other than that of the concordant segment. These findings contrast with those of Chiradejnant et al⁴, who reported that mobilization at the most symptomatic or dysfunctional lumbar segment was more effective for pain relief than at a randomly selected one. Additionally, neck pain has been alleviated by mobilization and manipulation of the thoracic spine, supporting the hypothesis that treatment for pain in a specific anatomical region may be effective when performed at distances away from the symptomatic segment^{28–30}.

Whether the lack of difference in findings specific to cervical spine treatment is associated with the use of mobilization and/or manipulation is un-

known. Many have reported no difference in the effects of mobilization and manipulation^{31–34}, yet further comparative information using the same design as this study would provide valuable insight. The mechanisms of the effects of mobilization remain unclear, specifically when similar results are found at 3 levels from the concordant site.

Multiple neurophysiologic mechanisms may explain how physiotherapy can influence pain^{35,36}. It is likely that all manual mechanisms provide sensory input that ultimately inhibits pain signals³⁷, although where these stimulations are applied best is not completely clear at this time. Neurophysiologic explanations for pain treatment at a distance from the painful region exist, such as the mechanisms of diffuse noxious inhibition control or counter-irritation³⁸.

Mechanical explanations are also possible. Kulig et al³⁹ suggested that a postero-anterior (PA) mobilization targeted to L3 may inadvertently influence lumbar pain at L5. A PA mobilization at L3 causes extension at L5, without direct contact with that segment. Traditionally, manual therapists target hypomobility with an abnormal end feel (versus pain)

for mobilization or manipulation². This is especially apropos for the spine, where active movements generally involve more than one segment simultaneously. Many manual therapists have adopted the theory that treatment of the original hypomobile dysfunction (which may or may not be painless) can alleviate pain in a distant segment. An obvious example is mobilization of the hypomobile thoracic spine to take some strain off the (painful) cervical spine.

Limitations

There are a number of limitations to this study. Some participants tolerated minor pressures from the physiotherapist-researcher's hand; thus, it is uncertain if movement was isolated to soft tissue only. Differences between treatment A and B might have been too small to detect a different effect between the two groups. Further, instruction of the patients was not completely standardized. Some participants understood the procedural requirements of the study very quickly whereas others required extended explanations. Movements for symptom localization tests and for treatment were not standardized by technical means regarding direction, force, and frequency. All interventions were performed by the same person. This ensures homogeneity of intervention but limits the ability to transfer the results to other situations/physiotherapists.

The same physiotherapist researcher was responsible for examining, applying the treatment, and measuring the findings, and was not totally blinded to allocation. To reduce bias, participants completed the NRS after treatment without being seen by the physiotherapist-researcher so that he did not know the results during the data collection period. Some instances required assistance for completion of NRS, a previously documented problem⁴⁰.

The significant difference in age between groups A and B may be one cause for no differences in findings between both groups. Most participants had been directly asked if they would like to join the study, and the free examination and treatment may have motivated them to agree. A less self-selective population

would have involved patients enrolled after a referral from medical physicians.

Conclusion

This study suggests that therapeutic movement has pain-alleviating effects even when applied at a distance from the concordant segment and provides similar immediate effects of reduction in pain intensity and improvement in sensation of movement. Hypothetical explanations of similar effects may be associated with neurophysiologic and mechanical results. Further research should consider the above-mentioned limitations and investigate how far from the painful segment/joint treatment is still effective. Subgroups of neck pain should be examined, and pain intensity might be ≥ 3 on an 11-point NRS as an inclusion criterion. Furthermore, it would be interesting to evaluate the effect of a treatment of a painless dysfunction, for example, mobilization of a painless but hypomobile C2 segment to alleviate pain in a hypermobile C5 segment.

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