

The Immediate Effects of a Cervical Lateral Glide Treatment Technique in Patients With Neurogenic Cervicobrachial Pain

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Study Design: Randomized clinical trial.

Objectives: To analyze the immediate treatment effects of cervical mobilization and therapeutic ultrasound in patients with neurogenic cervicobrachial pain.

Background: Different treatment modalities have been described for patients with neurogenic cervicobrachial pain. Although it has been suggested that a more specific approach, like cervical mobilization, would be more effective, effect studies are scarce.

Methods and Measures: Twenty patients with subacute peripheral neurogenic cervicobrachial pain were assessed. Besides other criteria, patients were included if a cervical segmental motion restriction was present which could be regarded as a possible cause of the neurogenic disorder. Patients were randomly assigned to a mobilization or ultrasound group. Mobilization consisted of a contralateral lateral glide technique. The range of elbow extension, symptom distribution, and pain intensity during the neural tissue provocation test for the median nerve were used as outcome measures. Results were analyzed using a 2-way mixed-design ANOVA.

Results: Significant differences in treatment effects between the 2 groups could be observed for all outcome measures ($P \leq .0306$). For the mobilization group, the increase in elbow extension from 137.3° to 156.7°, the 43.4% decrease in area of symptom distribution, and the decreased pain intensity from 7.3 to 5.8 were significant ($P \leq .0003$). For the ultrasound group, there were no significant improvements ($P \geq .0521$).

Conclusions: When a cervical dysfunction can be regarded as a cause of the neurogenic disorder or as a contributing factor that impedes natural recovery, a cervical lateral glide mobilization has positive immediate effects in patients with subacute peripheral neurogenic cervicobrachial pain. This movement-based approach seems preferable to ultrasound. *J Orthop Sports Phys Ther* 2003;33:369–378.

Key Words: Brachial plexus, cervical spine, manipulative therapy, manual therapy, neurodynamic test

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An important factor in the effectiveness of the management of patients with subacute neuromusculoskeletal disorders is the ability to determine the relative contribution of various structures and the different pain mechanisms involved. Tests that are commonly used to assist in structural differentiation are tests that assess the mechanosensitivity of peripheral nerves, like the straight leg raise test, prone knee bend test, and the neural tissue provocation test with a median nerve bias (NTPT1).^{24,26} Closely associated with the use of movement to assess neurogenic pain disorders is the use of movement as treatment modality. Analogous to the management of various nonneural injuries, several authors advocate that controlled movement in minor neurogenic disorders has beneficial effects throughout different stages of tissue repair.^{30,38,41} Although this approach is considered useful in clinical practice,^{4,14} studies analyzing the effects of a movement-based treatment approach in patients with minor peripheral nerve injuries remain scarce.

During movement, nerves glide extensively in regard to their surrounding structures.^{42,45} Recent

research has demonstrated reduced median nerve movement at the wrist in patients with carpal tunnel syndrome (CTS) and nonspecific arm pain.^{3,16,27} Two suggested approaches to restore this impaired movement are (1) facilitation of nerve gliding by controlled angular joint movement^{4,30} and (2) mobilization of the surrounding structures while keeping the nerve comparatively still.^{15,17} The efficacy of a combined approach has been analyzed in the conservative treatment of patients with CTS: a substantially smaller amount of patients with CTS who performed median nerve and flexor tendon gliding exercises underwent surgery when compared to a standard conservative treatment of immobilization and medication.³⁰

While CTS is a well-defined clinical entity of neural entrapment, the tissue origin of numerous other musculoskeletal disorders is less straightforward. The potentially different tissues at fault within 1 syndrome and the difficulty of structural differentiation are important impediments to the designing of a causal treatment strategy. To assist in differential diagnosis and to identify the presence of a neurogenic disorder amenable to physical therapy management, a set of clinical tests has been formulated by Elvey.¹⁴ Although the applicability of these criteria has been illustrated in some case reports,^{11,14} the prescriptive validity of this set of tests, derived from the successfulness of the chosen treatment inferred from the outcome of these tests, has not sufficiently been demonstrated yet.¹³

The primary aim of this study was to compare the immediate treatment effects of 2 clearly different treatment modalities in patients who met the above-mentioned set of criteria. We hypothesized that controlled passive movements of the anatomical structures that surround the nerve are more effective than a non-movement-based intervention that does not directly target the peripheral nerve or its surrounding structures. More specifically, we hypothesized that cervical mobilization was more effective than therapeutic ultrasound. As neurodynamic tests are not only used as diagnostic tools, but also to evaluate treatment progressions,^{36,37,39} the NTPT1 was used to analyze the immediate effects of treatment.

Besides the hypothesis regarding the effect of treatment, we also analyzed whether differences in range of motion (ROM), symptom provocation, and pain intensity could be demonstrated when performing the NTPT1 on the involved and uninvolved side in patients with unilateral symptoms. This issue is important because some authors question the discriminatory ability of neural provocation tests, as sensory responses and a limitation in ROM are also frequently present in the absence of pathology.¹³ The inability to demonstrate abnormalities in case of pathology would indeed compromise the use of these tests as diagnostic tools or outcome measures. Fur-

thermore, determining the magnitude of the differences between the involved and uninvolved side enabled us to more meaningfully interpret the size of the treatment effect.

METHODS

Subjects

Twenty patients referred from general medical practices with subacute unilateral or bilateral brachial or cervicobrachial neurogenic pain volunteered to participate. Fifteen patients had unilateral symptoms and 5 had bilateral symptoms. The subacute period was defined as 2 weeks to 6 months after the onset of symptoms or recurrence of previous symptoms. The standard classification systems of Seddon³² and Sunderland³⁵ for the more severe neuropathies could not be used to categorize the patients, as hyperalgesia was the dominant characteristic and not loss of nerve function. In anticipation of a more up-to-date classification of neuropathies, which would also include neurophysiological changes like abnormal impulse generation, disorders could best be described as minor peripheral nerve injuries. It is important to emphasize that "minor" refers to the limited symptoms related to conduction loss and not necessarily to the intensity of symptoms as indicated by pain perception, for instance.

Patients were referred for physical therapy management and were included in the study if the interview was suggestive of a peripheral neurogenic disorder amenable to physical therapy management and if the following physical signs were present: (1) an active movement dysfunction related to noncompliance of the median nerve, (2) a passive movement dysfunction correlating with the active dysfunction, (3) an adverse response to median nerve palpation, (4) a positive NTPT1, and (5) a sign of a local musculoskeletal dysfunction that would indicate a possible cause of the neurogenic disorder that would be responsive to physical therapy management.^{14,17}

Due to the release of neuropeptides by the nervi nervorum,^{31,47} or due to the presence of mechanosensitive abnormal impulse-generating sites,^{5,12} movement and palpation of an injured nerve may provoke painful mechanical stimuli, accounting for positive test findings for the first 4 criteria. An example of an active and passive movement dysfunction related to noncompliance of the median nerve is more limited shoulder abduction when performed with the wrist in extension, or less limited shoulder abduction when the cervical spine is positioned in ipsilateral lateral flexion. Anatomical studies have demonstrated that both wrist extension and cervical lateral flexion alter the tension in the neural structures around the shoulder.^{23,25} Median nerve palpation was performed at the upper arm, elbow, and wrist. Palpation was

considered positive if there was a more painful response than on the uninvolved side in at least 1 region or, in patients with bilateral pain, if the response was more painful than what could be considered normal. Concerning the fourth criterion, a positive NTPT1 implied that the patient's symptoms could, at least partially, be reproduced. Furthermore, these symptoms had to increase or decrease when the amount of nerve provocation was varied by changing a distant test component that had no direct structural link with the symptomatic area except via the nervous system. Clinical support for this approach has recently been established by demonstrating a cumulative and neutralizing impact on the nervous system when the number of simultaneously applied test components was varied.^{7,10,19} The fifth criterion pertaining to a local musculoskeletal dysfunction has been added to exclude patients with a nonmusculoskeletal cause of neurogenic pain that was not amenable to physical therapy, like diabetic neuropathy.¹⁴ In this study, patients were included if manual examination by a trained manipulative therapist revealed a cervical segmental motion restriction as a possible cause of the neurogenic disorder. It has been demonstrated that manual examination can accurately diagnose the segmental level of a cervical dysfunction.²⁰

Separate characteristics of the patients of the mobilization and ultrasound group are listed in Table 1. There were no significant differences between the 2 groups. All subjects signed a consent form before entering the study and approval was granted by the Doctoral Advisory Board, Faculty of Physical Education and Physiotherapy, University of Leuven.

Treatment Conditions

Cervical Mobilization A cervical segmental contralateral lateral glide treatment technique was per-

formed at 1 or more motion segments of the cervical spine (C5-T1), including the level(s) of the segmental motion restriction. With the patient in a supine position, the therapist cradled the head and neck above, and including, the level to be treated and performed a lateral translatory movement away from the involved side while minimizing gross cervical side flexion or rotation (Figure 1).⁴⁰ This technique was aimed to move the structures around the nerve¹⁷ and has been described and analyzed in detail.⁴⁰ Because the therapist was allowed to vary the technique in regard to duration, amplitude, and frequency, the treatment characteristics used for each patient were recorded at the end of the intervention. Table 2 summarizes how the treatment was performed.

During the lateral glide, several components of the NTPT1 were applied on the involved side, which is considered to preload the median nerve and brachial plexus (Figure 1). If this position was uncomfortable, the patient's arm was positioned in an unloaded position, ie, with the hand on the abdomen and the elbow supported by a pillow.

Therapeutic Ultrasound Therapeutic ultrasound was applied for a period of 5 minutes at the most painful region (dose, 0.5 W/cm²; sonation time, 20%; size of treatment head, 5 cm²; frequency, 1 MHz) using a Sonopuls 950 ultrasound unit (Enraf Nonius, Delft, The Netherlands). The arm was positioned in an unloaded position. There were several reasons why we decided to use ultrasound in this study: first, because it reflects current physical therapy practice, and second, because we wanted to compare a movement-based treatment approach (mobilization) with a non-movement-based approach (ultrasound). As minor arm movements, whether active or passive, result in gliding of peripheral nerves in regard to their surrounding structures,^{42,45}

TABLE 1. Characteristics of the subjects in the cervical mobilization and therapeutic ultrasound groups.

	Mobilization Group	Ultrasound Group	P Value*
Sex	Females, n = 8 Males, n = 2	Females, n = 8 Males, n = 2	
Age (mean ± SD)	49.1 ± 14.1 y	46.6 ± 12.1 y	0.67
Sides involved	Unilateral, n = 7 Bilateral, n = 3	Unilateral, n = 8 Bilateral, n = 2	1.00
Mean duration of symptoms	2.7 (median, 2.0) mo	3.2 (median, 2.8) mo	0.58
Classification within nonacute	First episode, n = 7 Recurrence, n = 3	First episode, n = 5 Recurrence, n = 5	0.65
Elbow range of motion (mean ± SD) during NTPT1 [†]	137.3° ± 15.4°	127.5° ± 19.3°	0.23
Elicited pain intensity (mean ± SD) during NTPT1 [‡]	7.3 ± 1.8	7.7 ± 1.9	0.68
Area of symptom distribution (mean ± SD) during NTPT1 [§]	22.3% ± 13.2%	26.7% ± 13.0%	0.47

* Results of unpaired *t* tests for continuous data and Fisher's exact tests for categorical data; all results nonsignificant.

[†] NTPT1, neural tissue provocation test (median nerve bias); before treatment.

[‡] Based on a 0-to-10 numeric scale; before treatment.

[§] Expressed as percentage of total ventral area of upper quadrant; before treatment.



FIGURE 1. The contralateral lateral glide treatment technique.

TABLE 2. Description of the different treatment characteristics.

Amplitude	
Grade 1	Small-amplitude movement at the beginning of the range
Grade 2	Large-amplitude movement without moving into resistance
Grade 3	Large-amplitude movement up to the limit of the range
Grade 4	Small-amplitude movement at the limit of the range
Frequency	
High	>2 repetitions/sec
Low	2-3 sec/repetition
Sustained	>5 sec/repetition

many other interventions were not suitable for this comparison

Outcome Measures

The dependent variables were the available range of elbow extension, the distribution of the symptoms, and the pain intensity during the NTPT1. This neurodynamic test consists of a sequence of passive maneuvers elongating the length of the nerve bedding of the brachial plexus and median nerve.^{4,14,33} Whereas electrodiagnostic tests examine nerve conduction, neurodynamic tests assess an increased mechanosensitivity by gradually loading part of the nervous system.³⁴ In this experiment, the test was sequenced as follows: shoulder abduction and external rotation to 90° while the shoulder girdle was maintained in a neutral position, wrist extension and supination of the forearm, followed by extension of the elbow. The hand and fingers were kept in a neutral (anatomical) position. Figure 2 demonstrates the experimental setup. A load cell (model 535QD, DS Europe, Milan, Italy) was used to standardize the amount of shoulder girdle depression. An armrest and head restraint were used to standardize the



FIGURE 2. The experimental set-up, showing the position of the subject, the load cell (1), the electrogoniometer at the elbow (2), the electrogoniometer at the wrist (3 [not used in this experiment]), the amplifier and digital display of the load cell (4), the base unit (5a) and patient unit (5b) for the electrogoniometers, the head restraint (6), the armrest (7), and a hand-held switch (8 [not used in this experiment]).

position of the arm and to prevent ipsilateral lateral flexion of the head during the NTPT1. A more detailed description of the experimental devices and procedures have been reported elsewhere.⁸

Range of Motion The available ROM during neurodynamic testing is frequently used to appraise the mechanosensitivity and extensibility of the nervous system²⁸ and was regarded as the principal outcome measure. The available range of elbow extension when the patient reported the occurrence of a substantial discomfort was measured with an electrogoniometer (model M180, Penny and Giles Biometrics Ltd., Gwent, UK) and was regarded as the maximal amplitude. Prior to starting the experiment, substantial discomfort was described to the patient as “the maximal tolerance level for the test, knowing that the test had to be performed repeatedly.” The discomfort concurred with the partial or full reproduction of symptoms. A reliability study has demonstrated excellent reliability for this measure ($ICC_{2,1} = 0.98$; $SEM = 2.8^\circ$).⁹ Results showed that a difference between 2 measurements greater than 7.7° represents a real (nonerror) change. When a mean score of 3 repetitions was used as the unit of analysis, improvements as small as 4.4° represent statistically meaningful differences ($ICC_{2,3} = 0.99$; $SEM = 1.6^\circ$).

Symptom Distribution On completion of the NTPT1, the patient pointed out the location of the symptoms on the involved upper quadrant while remaining in the supine position. The test leader recorded the distribution of the symptoms elicited by the test on a body chart. Subsequently, the patient verified if the recordings on the body chart corresponded exactly with the location of the symptoms. The patient was then asked to describe the quality of the symptoms that were elicited in the upper quadrant.

Pain Intensity Although patients were asked to always halt the test when submaximal pain was elicited, that is, both before and after treatment, we considered it useful to also record the intensity of the elicited discomfort. Interpretation of an improvement in ROM, for example, would be difficult if this increase in ROM was accompanied by an increase in pain intensity. However, we anticipated that the intensity of pain would be the same before and after treatment. The intensity of the symptoms elicited during the NTPT1 was evaluated using a numeric pain intensity scale ranging from 0 to 10, the borders of which were defined as “no pain” and “pain as bad as it could be.”

Procedure

Patients were selected during the initial physical therapy session and a separate appointment for the experiments was scheduled before the actual treatment commenced. Group allocation was concealed by using opaque sealed envelopes for the randomization. There were no significant differences in patient characteristics and test responses before treatment between the 2 treatment groups (Table 1). The test leader performed the baseline measurements. For the patients with unilateral pain, the tests were first performed on the uninvolved side and subsequently on the involved side. For the patients with bilateral pain, the side in which symptoms could best be reproduced by the NTPT1 was tested. After 2 trial runs to familiarize the patient with the test, 3 repetitions of the NTPT1 were performed. Thereupon, the intensity, distribution, and quality of the symptoms were recorded. Subsequently, mobilization or ultrasound was administered in the absence of the test leader. Communication between the patient, therapist, and test leader was kept to a minimum and was standardized between the 2 conditions. Immediately after the application of either intervention, the test leader, who was blinded from the patient's group allocation, performed the outcome measurements. The treating therapist was absent during all measurements and both treatment modalities were administered by the same therapist.

Data Analysis

A 1-way, repeated-measures ANOVA was used to analyze differences between the involved and uninvolved side for the 15 patients with unilateral symptoms. For the elbow ROM, the mean of 3 repetitions was used as input for the statistical analysis. To compare the distribution of symptoms, a 50×50 grid was laid over the body chart enabling quantification of the size of the area of the elicited responses before the analysis of variance was performed. Quantification of the size of the area was performed by calculating the number of squares. If the symptoms were pointed out in part of a square, the square was not included in the calculation if not at least 50% of the square was covered.

Unpaired *t* tests and Fisher exact tests were used to compare the characteristics of the mobilization and ultrasound group.

To analyze the effect of treatment, a 2-way mixed-design ANOVA was used, with 1 between-group factor (group, with 2 levels: mobilization and ultrasound) and 1 repeated-measures factor (time, with 2 levels: before and after treatment). In case of a significant interaction, simple effects were calculated. The level of significance chosen was $P < .05$.

RESULTS

Table 3 presents the differences between the involved and uninvolved side regarding the responses during the NTPT1. The mean difference (\pm SD) in the range of elbow extension was $25.6^\circ \pm 21.3^\circ$ (range, -3.3° – 59.6°), the mean difference (\pm SD) in pain intensity was 3.1 ± 1.9 points (range, -0.3 – 7.5 points) on a numeric pain intensity scale, and the symptomatic area was approximately 2.9 times larger. The reduced ROM, increased pain intensity, and larger symptomatic area on the involved side were all significant (Table 3). Figure 3 demonstrates the location and frequency distribution of the elicited sensory responses during the test. Regarding the quality of the sensory responses, sensations in the hand were mainly described as paresthesia (like numbness and pins and needles), whereas sensations around the elbow and lower and upper arm were predominantly described as an unpleasant feeling of

TABLE 3. Descriptive data (mean \pm SD) for the involved and uninvolved side for the available elbow range of motion (ROM), size of the area of symptom provocation, and pain intensity during the NTPT1 for the patients with unilateral symptoms ($n = 15$).

	Involved Side	Uninvolved Side	Statistical Analysis
Elbow ROM*	$132.0^\circ \pm 20.2^\circ$	$157.6^\circ \pm 12.4^\circ$	$F_{1,14} = 21.68; P = .0004$
Area of symptom provocation†	$26.4\% \pm 13.0\%$	$9.2\% \pm 6.7\%$	$F_{1,14} = 30.64; P < .0001$
Pain intensity‡	7.6 ± 2.0	4.5 ± 1.9	$F_{1,14} = 39.26; P < .0001$

* 180° corresponds to full range of elbow extension.

† Expressed as a percentage of the total ventral area of the upper quadrant.

‡ Based on a 0-to-10 numeric scale.

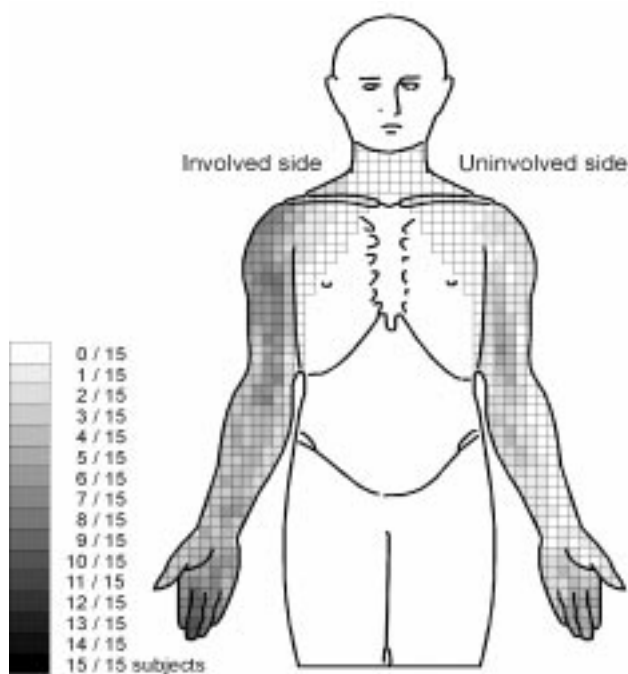


FIGURE 3. The distribution of the elicited sensory responses during the test. Regardless of which side was involved, the right arm summarizes the involved side and the left arm presents the uninvolved side. The darker the color, the more subjects reported symptoms in that area. The area of symptom provocation on the involved side was significantly larger (approximately 3 times) than on the uninvolved side.

stretch. All symptoms were elicited during the final test component, ie, during elbow extension.

Analysis of the characteristics of the cervical mobilization revealed a mean (\pm SD) treatment time of approximately 4.5 ± 1.5 (04:25 \pm 01:27) minutes. Most

often, 3 to 4 series of mobilizations were performed (3.4 ± 0.5). In the first series, the lateral glide was most often applied as a grade-2 technique, from then on as a grade-3 technique. The most frequently treated spinal levels were C5, C6, and C7 at a low frequency. Therapeutic ultrasound was more often applied at the more distal parts of the upper quadrant than at the neck.

All participants received the treatment as allocated and the outcome measures were obtained from all patients. The analysis of variance revealed a significant group \times time interaction for all 3 dependent variables ($F_{1,18} \geq 5.51$; $P \leq .0306$). Figure 4 illustrates the interaction for the ROM, pain intensity, and area of symptom provocation. Tests for simple effects demonstrated a significant improvement in elbow ROM ($19.4^\circ \pm 11.8^\circ$; range, 6.2° – 46° ; $P = .0002$) and a significant reduction in pain intensity (-1.5 ± 1.3 ; range, -0.3 – 4.0 ; $P = .0003$) for the cervical mobilization group. The 43.4% reduction in area of symptoms provocation was also significant ($P = .0002$). The ultrasound group demonstrated no significant change in ROM ($0.9^\circ \pm 5.4^\circ$; range, -7.0 – 7.8 ; $P = .7497$) or pain intensity (-0.4 ± 0.6 ; range, 0.5 – 1.0 ; $P = .2850$). The 14% reduction in area of symptom provocation was also not significant ($P = .0521$). Noteworthy is the large variability for the effect of treatment for the mobilization group, whereas the patients in the ultrasound group demonstrated a rather uniform lack of effect.

Figure 5 was constructed to illustrate the effect of treatment on the distribution of the elicited symptoms. The decrease in symptom distribution was not limited to the median nerve distribution.

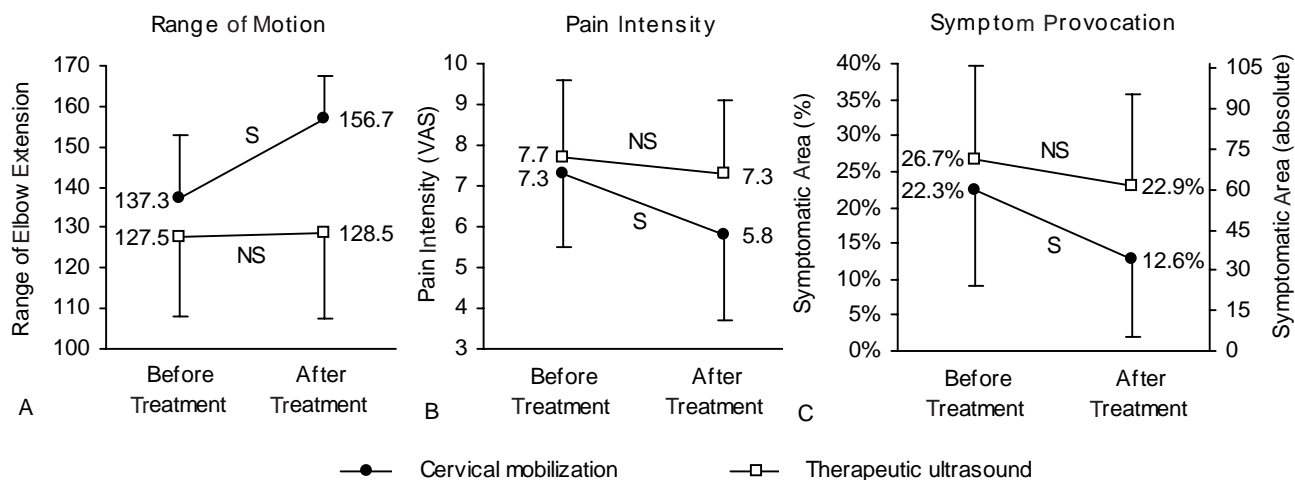


FIGURE 4. The effect of treatment for the 2 treatment groups for the available elbow range of motion (A), pain intensity (B), and the size of the area of symptom provocation (C) during the NTPT1. S, significant; NS, not significant. The error bars represent 1 standard deviation. One hundred and eighty degrees represents full range of elbow extension. Pain intensity is based on a 0-to-10 numeric scale. The area of symptom provocation is expressed as a percentage of the total ventral area of the upper quadrant and as the absolute number of squares on the body chart (see Figure 5).

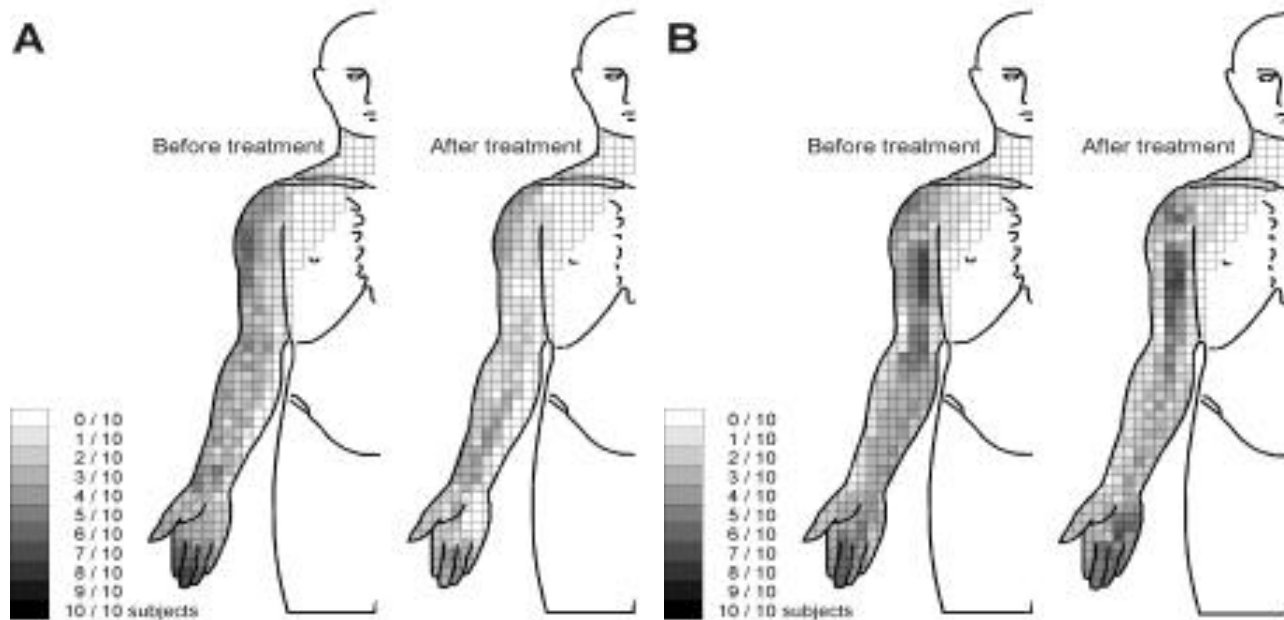


FIGURE 5. The effect of treatment on the area of symptom provocation for the cervical mobilization group (A) and ultrasound group (B). Regardless of which side was involved, the distribution of symptoms is summarized on the right arm. The decrease for the mobilization group was 43.4%, whereas the decrease for the ultrasound group was limited to 14.0%.

DISCUSSION

As some authors contest the fact that neural provocation tests can reveal aberrations in case of pathology,¹³ we analyzed the magnitude of the side differences when the NTPT1 was performed in patients with unilateral neurogenic cervicobrachial pain. From a statistical as well as a clinical point of view, the recorded side differences for the available elbow ROM, elicited-pain intensity, and area of symptom distribution were meaningful. This finding demonstrates that the presence of sensory responses, a limitation in ROM, and pain provocation during neural provocation tests in asymptomatic subjects does not compromise the test's discriminatory ability in case of pathology.

The analysis of the immediate treatment effects revealed that significant differences could be observed between the effects of cervical mobilization and therapeutic ultrasound. As we only analyzed the immediate effects of treatment, we cannot conclude that therapeutic ultrasound has no effect in the treatment of patients with peripheral nerve disorders amenable to physical therapy management. However, due to the lack of immediate effects, we will not further discuss this modality in this section.

Following the cervical contralateral lateral glide, the available ROM, area of symptom distribution, and elicited-pain intensity showed a significant improvement when compared to the situation before treatment. It is especially the simultaneous improvement

of all 3 signs that illustrates the advantage of cervical mobilization: even though the mechanical loading of the nervous system was larger in the posttreatment assessment due to an increased ROM during the test, the area of the elicited symptoms was smaller and the pain intensity was lower. This demonstrates that, although patients were asked to halt the test when submaximal pain was elicited, it was no longer possible to provoke the same intensity of pain following mobilization, despite the fact that the test was taken to a larger amplitude.

Whereas the interpretation of changes in ROM and pain intensity is rather straightforward, the area of symptom distribution requires some consideration. The fact that symptoms were elicited in a larger area than the distribution of the median nerve is in agreement with previous studies.^{7,22} These symptoms may be referred responses from the nervi nervorum that innervate the median nerve and brachial plexus, or may be due to the loading of other nerve segments, especially in the presence of neuroanatomical variations, triggering a mechanosensitive ectopic-impulse-generating site or stimulating the nervi nervorum. Of course, many nonneural structures that may be responsible for some of the symptoms are challenged as well. Also noteworthy is the fact that the treatment effect was not bound to the innervation area of the median nerve. The symptoms both inside and outside the median nerve distribution decreased following the cervical contralateral lateral

glide. Again, it is difficult to determine the exact origin of these symptoms.

To the authors' knowledge, only a few previous studies analyzed the effects of a cervical contralateral lateral glide in a patient population. Vicenzino et al³⁹ demonstrated an average increase of 7° for the neurodynamic test for the radial nerve and an increased pain threshold and grip strength when the lateral glide was performed on patients with lateral epicondylalgia. Even though lateral epicondylalgia is relatively often associated with radial nerve entrapment,^{1,18} and although the neurodynamic test for the radial nerve may reveal aberrations in patients with lateral epicondylalgia,^{44,46} patients were selected using clinical tests directed to musculotendinous structures only. It is important to emphasize that in this study, the neurodynamic test was used as a pain-provoking test, not as a diagnostic test. Although it is impossible to compare these results with the present findings, the relatively large improvement in our study suggests that Elvey's set of criteria¹⁴ may indeed be feasible and valid in the identification of patients with neurogenic disorders amenable to physical therapy treatment.

Allison et al² analyzed the effect of a lateral glide treatment technique as part of a wider approach directed to the peripheral nervous system and its surrounding structures (including shoulder girdle oscillations, contract-relax techniques for shoulder muscles, and a home exercise program) in patients with neurogenic pain. This intervention was compared with a nonspecific treatment that was not directly intended to affect the nerve bed (mobilization of the shoulder and thoracic spine, and a home exercise program that included stretching of shoulder muscles, ROM exercises, and theraband exercises). Both groups demonstrated a significant improvement when compared to the patients of a control group, who received no physical therapy treatment. As joint movement generates nerve movement at relatively remote areas,^{23,45} the question arises as to whether the movement of nerves and their surrounding structures relative to each other can be regarded as the common ground to explain the improvements in both groups. Analyzing the effect of a single modality of the intervention, like the cervical lateral glide, was not an aim of this study.

Awaiting studies with a longer follow-up period, we assume that a gently applied contralateral lateral glide treatment technique applied at 1 or more cervical motion segments is an effective component of the physical therapy management of patients with subacute neurogenic disorders who meet the inclusion criteria formulated by Elvey and who have a cervical dysfunction as a possible contributing factor for the neurogenic dysfunction. Considering the fact that minimal pressure on a nerve may cause important changes in vital physiological processes,

like intraneural microcirculation and axonal transport,²⁹ we assume that a segmental motion dysfunction may indeed be an important contributing factor in the genesis and maintenance of a minor neurogenic disorder. Further biomechanical and physiological studies are required to support this statement.

The results of this study are in agreement with the findings that cervical mobilization reduces pain and disability^{21,39} and, more specifically, with studies illustrating the benefits of a movement-based treatment approach of patients with peripheral neurogenic pain.^{2,30,36} Besides the capacity of the central nervous system to control the transmission of nociceptive impulses and the potential activation of descending pain inhibitory systems by joint mobilization,^{39,43} various definite hypotheses have been formulated that may explain the effects of treatment, like reducing mechanical forces on nerves, dispersing irritating chemicals and fluids in and around nerves and neurons, enhancing vascularity, and stretching scar tissue.⁴ Most of these hypotheses still have to be examined in a systematic way.

Based on the relatively large interindividual differences regarding the effect of cervical mobilization, the question arises as to whether an intervention that aims to address local dysfunctions is the most optimal approach for all patients who meet the previously formulated criteria. Although we tried to select patients with predominantly peripheral neurogenic disorders, central processes are always involved to a certain extent. Local dysfunctions, like positive neurodynamic tests, nerve palpation and spinal motion dysfunctions, are probably less meaningful in the case of a more dominant nervous system state of central sensitization.⁶ Indications during the patient interview and physical examination are likely to play a vital role in identifying these patients. Due to the relatively small sample size, it was not possible to infer patient characteristics corresponding with treatment outcome. Future research focusing on these characteristics is essential to reduce the variability in patient selection in clinical trials and to further optimize clinical practice.

CONCLUSIONS

A cervical lateral glide mobilization has positive immediate effects in patients with subacute peripheral neurogenic cervicobrachial pain if a cervical segmental motion restriction is present which can be regarded as a plausible cause of the neurogenic disorder or as a contributing factor that impedes natural recovery. Substantial improvements in elbow ROM, size of the area of symptom provocation, and pain intensity during the NTPT1 could be observed following cervical mobilization. These findings sug-

gest that, when considering the immediate effects, cervical mobilization is preferable above the use of therapeutic ultrasound.

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