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The effect of neural tissue mobilization techniques on pain, functioning and health in patients with median nerve entrapment in mild to moderate carpal tunnel syndrome: A narrative review

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Abstract

In Carpal Tunnel Syndrome (CTS), compression and ischemia of the median nerve are caused leading to pain and paraesthesia as it courses through the hand. Neural tissue mobilization techniques help reduce pain and improve the functioning of the patient. The aim of this literature review is through recent studies to outline the effect of neural tissue mobilization techniques on pain and functioning in patients with median nerve entrapment in mild to moderate CTS. Google Scholar and PubMed were searched in English with the following keywords: Carpal tunnel syndrome, median nerve, manual therapy, neurodynamic techniques, mobilization, Efficacy. The review included randomized clinical trials, comparative studies, and case studies. 17 sources were included in this review of which 13 were randomized clinical trials, three comparative studies and one case study. Discussion - Conclusions: The results of this review show that neural tissue mobilization techniques have a significant positive effect on reducing pain, severity of symptoms and increasing functioning in patients with nerve entrapment in mild to moderate CTS. On average, interventions are needed three times a week for a period of 2-24 weeks. More studies will be needed to further investigate the effects of these techniques.

Keywords: Carpal tunnel syndrome, median nerve, manual therapy, neurodynamic techniques, mobilization, efficacy

Introduction

The median nerve (C6-C8, T1) belongs to the brachial plexus and specifically comes from the junction of part of the inner root and the inner trunk located in front of the axillary artery. For the sensory part, it innerves the palmar surface of the first three and a half fingers and dorsally the distal phalanges of the second and third fingers ^[1]. In Carpal Tunnel Syndrome (CTS), compression and ischemia of the median nerve are caused leading to pain and paraesthesia as it courses through the hand ^[2]. Diseases and injuries that lead to pressure on the median nerve in the carpal tunnel are fractures, tenosynovitis, cysts, tumors, dislocations in the wrist, diabetes, tendon strain and joint position change, obesity, etc. ^[3]. The opponens pollicis, abductor pollicis, superficial head of the flexor pollicis brevis and 1st and 2nd lumbricals are affected. There is also difficulty in the adduction and abduction of the thumb perpendicular to the palm, in the bending of the first phalanx of the thumb and the first phalanges of the index and middle fingers. It can be diagnosed with Phalen's test (pain when bending the wrist for one minute) and Tinel's sign (pressure pain in the carpal tunnel) ^[4].

CTS is the most common pressure nerve disorder of the upper limbs. In the USA, 500000 cases are reported annually and its idiopathic form is the most common in adults ^[5]. Women are affected much more often than men, especially those in the ages 50-59. Furthermore, the profession plays a very important role in the appearance of CTS and for this reason in rural and industrial areas the frequency is much higher than in urban areas ^[6]. During conservative treatment, within six weeks 80% of patients show signs of relief, but only 20% are free of symptoms after one year. The rest of the patients have to be treated surgically ^[5].

Physiotherapy has been proven to help treat mild to moderate CTS with a range of interventions that reduce pain, make the patient functional and delay or postpone surgery. The guidelines state the following steps: 1. Nerve protection, 2. Modification of activities and patient training, 3. Mobilization of limited joints, connective tissue, nerves, muscles and tendons, 4. Improvement of muscle performance and 5. Functional independence^[7].

The aim of this literature review is through recent studies to outline the effect of neural tissue mobilization techniques on pain and functioning in patients with median nerve entrapment in mild to moderate CTS.

Literature review

Google Scholar and PubMed were searched in English with the following keywords: Carpal tunnel syndrome, median nerve, manual therapy, neurodynamic techniques, mobilization, efficacy. The review included randomized clinical trials, comparative and case studies. The following are the main conclusions from the sources selected for this review.

Wolny and Linek^[8] studied 103 patients with mild to moderate CTS symptoms over a period of 10 weeks with a mean age of 53.95 years and the participants were randomly divided into two groups. Neurodynamic techniques were applied in the intervention group consisting of 58 people and in the control group (45 people) no treatment was given. The results showed that the neurodynamic techniques of manual therapy have significant benefits in the mild and moderate stage of CTS. Specifically: In the conduction of nerves (sensory conduction speed of intervention group: 38.3m/s, SD = 11.1 vs control group: 25.9m/s, SD = 7.72, $p < .01$), in pain (intervention group: 1.38, SD = 1.01 vs control group: 5.46, SD = 1.05, $p < .01$), in symptom severity (intervention group: 1.08, SD = 0.46 vs control group: 2.87, SD = 0.68, $p < .01$) and in functioning (intervention group: 1.96, SD = 0.64 vs control group: 2.87, SD = 1.12, $p < .01$). There were no differences between the two groups in terms of strength and endurance.

Wolny and Linek^[9] in a sample of 250 volunteers, 150 of whom had CTS, applied nerve tissue mobilization techniques, sliding and tension in one group, and placebo therapy in the other. The program was implemented for 10 weeks with 20 treatments in total and a frequency of two times per week. Symptom severity and functioning were measured with the Boston Carpal Tunnel Questionnaire (BCTQ). The results showed that neurodynamic techniques have a positive effect on mild and moderate CTS. In the evaluation of pain, on the scale of functioning and severity of symptoms all measurements were $p < .01$. There was no difference between the 2 groups in the evaluation of the force in closing and shaking the hand ($p > .05$).

Wolny *et al.*^[10] studied 140 patients with mild to moderate CTS symptoms for 10 weeks. The participants were randomly divided into two groups. In the first group, manual therapy techniques were applied, including neural tissue mobilization techniques, while in the second group, ultrasound and laser therapy were applied. Measurements were taken before and after interventions and the severity of symptoms, functioning and pain were measured with BCTQ. The results showed changes in the sensory conductivity ($p < .01$) of the median nerve, but not in the kinetic ($p = .82$). A follow-up measurement was conducted four weeks after the end of the treatment. In the group that applied the manual therapy

techniques (MT), the speed of sensory conduction of the median nerve increased by 34% and the motor transfer by 6% (in both cases $p < .01$). There was no change in the group that followed the therapy with electrophysical modalities (EM). In addition, immediately after treatment the analysis showed a difference between the two groups in terms of pain severity ($p < .01$), with a reduction in both groups. (MT: 290%, $p < .01$; EM: 47%, $p < .01$). Moreover, there were changes in the appearance of symptoms ($p < .01$) and functioning ($p < .01$) in the measurements with BCTQ. Both groups showed improved functioning (MT: 47%, $p < .01$; EM: 9%, $p < .01$) and symptom reduction (MT: 67%, $p < .01$; EM: 15%, $p < .01$). Despite the positive effects for both groups, the results in terms of pain and functioning were better for the group that followed the program with manual therapy.

Wolny and Linek^[11] in this study attempted to investigate the efficacy of manual therapy, including neurodynamic techniques, in terms of Overall Health Status (OHS) in patients with mild to moderate CTS symptoms. 189 people were randomly divided into two groups. The first was treated with manual therapy techniques and the other group was not treated. The intervention lasted 10 weeks with two treatments per week. OHS was assessed using the RAND 36-Item Short Form Health Survey. The results showed a difference immediately after treatment with manual therapy techniques, in terms of physical and mental condition of patients (in all cases $p < .001$), in contrast to the control group (in all cases $p > .05$). The same results were maintained in the analysis after the end of the program. It can be concluded that manual therapy, including neural tissue mobilization techniques, has a positive effect on the overall health of patients with CTS.

Mohamed *et al.*^[12] examined the effectiveness of median nerve mobilization in relieving symptoms in CTS versus medication. 28 patients were divided into two groups. In the first group, 18 patients followed the program of mobilization techniques and in the second group, 10 patients received medication. The program had a duration of six weeks and pain, paresthesia, strength and thenar eminence atrophy were measured with Phalen's test and Tinel's sign, symptom severity scale, functional status scale and BCTQ. The results showed that median nerve slider techniques are more effective in the population with mild or moderate carpal tunnel symptoms.

De-la-Llave-Rincon *et al.*^[13] studied in 18 women with CTS whether the combination of neurodynamic median nerve and soft tissue slider techniques affects pain and pressure sensitivity. The results showed that they reduce the intensity of pain but not the sensitivity to pain under pressure. Specifically, one week after the intervention, a reduction in the intensity of hand pain was observed ($p < .01$).

Alam *et al.*^[14] in a sample of 48 patients with CTS, divided the participants into two groups with equal number of individuals and with the same symptoms (moderate to severe). Neural tissue mobilization techniques were applied in the first group and the second group was treated with ultrasound therapy. 12 sessions took place over a period of four weeks. The results showed that median nerve mobilization techniques were more effective than ultrasound therapy in reducing pain intensity and improving functioning. Data analysis was performed with the statistical program SPSS. Based on the measurements before and after the intervention and the p -value of $< .05$, the first group had a 100% reduction in symptoms, while 80% of the second group participants reported moderate pain.

Paquette *et al.* [15] evaluated one week before and one week after 14 patients with CTS, who followed a neural tissue mobilization program for four weeks. Upper limb pain and functioning were assessed with questionnaires and the median nerve with magnetic stimulator and ultrasound imaging. Participants reported moderate to great improvement in both pain ($p \leq 0.03$) and upper limb functioning ($p = .02$). In this study, neural tissue mobilization techniques were shown to be promising in reducing pain and increasing upper limb functioning.

Hamzeh *et al.* [16] studied the long-term benefits of applying specialized neurodynamic techniques as opposed to kinesiotherapy in CTS. In parallel blindly separated groups, 52 hands were analyzed from 41 patients (initial sample of 57 patients) before and after six months of treatment. The measurements showed positive results for both techniques, but with the application of neural tissue mobilization, functioning and strength were further improved and pain was reduced ($p < .05$).

Solanki and Samuel [17] compared the efficacy of neural mobilization in a sample of 30 individuals as opposed to Maitland musculoskeletal mobilization in CTS. 15 people were assigned to one group and another 15 to the other. The treatment lasted six weeks for both groups. Statistics showed that neurodynamic mobilization techniques were more effective in reducing pain and increasing range of motion.

Oskouei *et al.* [18] in 20 patients with CTS (32 hands), investigated the efficacy of neural tissue mobilization techniques in combination with conventional physiotherapy. Individuals were divided into an intervention and a control group. The results showed that the functional status scale (31% improvement versus 6%) and the median nerve response had a significant improvement only in the group receiving neurodynamic techniques, while the symptom severity scale, Phalen's test and median nerve pressure test exhibited improvement in both groups.

Talebi *et al.* [19] studied the effect of neurodynamic techniques of manual therapy in 30 patients with CTS and diabetes at the same time. The subjects were divided into a manual therapy group of 15 individuals and the remaining 15 were treated with electrotherapy (TENS, ultrasound). The treatment lasted four weeks and the sessions were three times per week for both groups. The functional status scale, symptom severity scale and median nerve neurodynamic test were measured before and after the intervention. The results showed a significant improvement in the group that followed the manual therapy in terms of functionality (18.33) compared to that of electrotherapy (16.5). The symptom severity scale was measured the same in both groups (29.91).

Goyal *et al.* [20] evaluated in 30 women with CTS patient their functioning and median motor nerve conduction. Using the randomization method, the patients were divided equally into two groups. In the first group, classical physiotherapy was applied, while in the second, neural tissue mobilization techniques were applied. Both groups followed the program for three weeks twice per week. The analysis of the results, which was performed with the statistical program SPSS and t-tests, showed significant progress in the meta-analysis for the second group in terms of pain, symptoms, functioning and speed of motor impulse of the median nerve ($p \leq .05$).

Kocjan [21] studied the effect of manual therapy techniques on pain relief, symptom severity and functioning in 36 patients with CTS. The individuals were divided equally into two groups and the intervention program had a duration of 21 days. In the first group techniques of mobilization of the

median nerve were applied, while in the second group a combination of these techniques with wrist tension techniques was applied. Measurements were made with the BCTQ, Visual Analog Scale and Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire. The results showed that both of these manual therapy techniques are effective in treating CTS, but their combination provides slightly greater benefits.

Kurniawati *et al.* [22] studied the effect of neural tissue mobilization techniques and Kinesio Taping in 20 patients with CTS, after they were first divided into two equal groups. The extraction of the results performed with SPSS, showed significant correlation of these two techniques and effectiveness in patients with CTS ($p < .05$). Neurodynamic techniques had a significant effect in reducing pain compared to Kinesio Taping.

Bartkowiak *et al.* [23] studied the efficacy of combination therapy with low-level laser or ultrasound with sliding of the neural tissue and tendon in patients with mild to moderate CTS. 70 people participated in this study and were divided into 2 groups where they received treatment for two weeks five times per week. In the first group, ultrasound treatment was applied and the second group was treated with low-level laser. Then, in both groups, the nerve and tendon slider techniques were applied three times on a daily basis. There was a positive effect in terms of symptom severity and functional status scales for both groups in combination with the techniques.

Andayani *et al.* [24] in 30 patients with CTS, studied the effect of ultrasound in combination with neural tissue mobilization techniques (intervention group) and ultrasound in combination with passive stretching (control group). The intervention had a duration of two weeks three times per week. From the baseline and follow-up measurements, there was a significant difference in the reduction of hand dysfunction by 15% in the intervention group compared to 7% in the control group.

Discussion - Results

The results of this review show that neural tissue mobilization techniques have a significant positive effect on reducing pain and increasing functioning in patients with median nerve entrapment in mild to moderate CTS. Their application was studied in comparison with electrotherapy, with other techniques of manual therapy, with medication, with classical physiotherapy and in relation to placebo therapies. The interventions had a duration in all cases of 2-24 weeks, which is the time that is usually required in order to show progress in the mild and moderate stage of the syndrome. Most researchers were found to apply these techniques two to five times per week. In all cases, the groups consisting of patients who underwent manual manipulation and slider techniques of the median nerve showed significantly better results on the scales of measuring pain, functioning and severity of symptoms. Median nerve conduction was also found to be improved due to these techniques. In one study, selected patients, in addition to CTS, also suffered from diabetes.

On the other hand, some studies found similar or even smaller benefits of neurodynamic techniques compared to other CTS techniques, such as Atya *et al.* [25], whose research concluded that low-level laser therapy was more effective. Other studies, suggest that neural tissue mobilization techniques do not have significant benefits for patients with CTS [26] while other researchers such as Basson *et al.* [27], find that the results of these techniques are not yet clear as to whether they affect the

parameters under investigation in these individuals. However, these techniques have only been applied in recent years to the conservative treatment of CTS, and for this reason there is not a significant number of studies that have dealt with this type of intervention, despite the growing interest [26]. For this reason, in this review, an attempt was

made to present the latest research data, consisting of studies that collect high scores. Although most studies had measurements before and after the intervention and were randomized, other studies with larger population samples will be needed to draw safer conclusions.

Table 1: Main characteristics of included studies

Author, Year	Number of participants	Intervention duration	Intervention	Conclusions
Alam <i>et al.</i> , 2018 [14]	n = 48	4w	Comparison: Group 1 - neural mobilization and Group 2 - ultrasound therapy with a predetermined intensity.	Median nerve neurodynamic techniques are more beneficial than ultrasound therapy in reducing pain intensity and functional limitations due to CTS.
De-la-Llave-Rincon <i>et al.</i> , 2012 [13]	n = 18	1w	Each received soft tissue mobilization and nerve slider neurodynamic technique directed at different anatomical sites of potential entrapment of the median nerve.	Soft tissue and neural mobilization techniques decreased the intensity of pain but did not change pressure pain sensitivity in this group of women with chronic CTS.
Hamzeh <i>et al.</i> , 2020 [16]	n = 57	24w	Four sessions of neurodynamic techniques and exercise or home exercise therapy alone as a control. Blinded assessment was performed before treatment allocation, at treatment completion, and six months post-treatment.	Although both treatments led to positive outcomes, neural mobilization therapy was superior in improving function and strength and in decreasing pain.
Mohamed <i>et al.</i> , 2016 [12]	n = 28	16w	18 patients underwent neural mobilization, and 10 patients underwent conventional medical treatment.	There was an improvement after neurodynamic techniques, which is better than conventional medical treatment. Manual therapy gives satisfactory results in conservative management of CTS.
Oskouei <i>et al.</i> , 2014 [18]	n = 20	12w	In both groups, patients followed the routine physiotherapy. Additionally, to the routine physiotherapy, patients in the treatment group followed neurodynamic techniques.	Neural mobilization, combined with routine physiotherapy shows more effective improvement in clinical findings than routine physiotherapy.
Paquette <i>et al.</i> , 2020 [15]	n = 14	4w	There was an assessment of pain and upper limb functional abilities by using standardized questionnaires. Quantification of the biological integrity and mechanical properties of the median nerve and the corticospinal excitability occurred by using musculoskeletal ultrasound imaging and transcranial magnetic stimulation, in retrospect.	The neural mobilization program seems to be a promising proposal regarding pain improvement and upper limb functional abilities in individuals with CTS.
Solanki <i>et al.</i> , 2015 [17]	n = 30	6w	Subjects in the first group followed neural mobilization and in the second group followed carpal bone mobilization technique.	CTS patients who received neural mobilization seemed to improve better than those who received CBM.
Talebi <i>et al.</i> , 2018 [19]	n = 30	4w	First group received TENS and ultrasound therapy and second group manual therapy techniques for the median nerve.	Manual techniques were used in mechanical interface of the median nerve and neural mobilization contain more accurate and significant effects on hand difficulties than interventions in diabetic patients with CTS.
Wolny and Linek, 2019 [8]	n = 103	10w	Neurodynamic techniques applied to the experimental group. Control group did not follow treatment.	Applying neurodynamic techniques in conservative treatment for mild to moderate forms of CTS has valuable therapeutic advantages.
Wolny and Linek, 2018 [10]	n = 250	10w	Neurodynamic techniques applied to the neurodynamic techniques group, and sham therapy applied to the placebo therapy group.	Applying neurodynamic techniques has a greater therapeutic result than placebo therapy in the treatment of mild and moderate forms of CTS.
Kurniawti and Hasbia, 2020 [22]	n = 20		Efficacy of neurodynamic techniques and Kinesio Taping.	Applying neural mobilization and Kinesio Taping showed effect toward changes in CTS with significant value of 0.004 and 0.011. Moreover, neural mobilization proved way more effective than Kinesio Taping in reducing the CTS pain.
Wolny <i>et al.</i> , 2017 [10]	n = 140	10w	Comparison: Applying neurodynamic techniques, functional massage, and carpal bone mobilization techniques (MT) with the electrophysical modalities (EM) as a conservative treatment for CTS.	Both treatments showed an optimal result of nerve conduction, pain reduction, functional status, and subjective symptoms in individuals with CTS. Nevertheless, when it comes to pain reduction, subjective symptoms, and functional status gave better results in the MT group.
Wolny and Linek, 2018 [11]	n = 189	10w	Applying manual therapy techniques, containing neurodynamic techniques and compared with no treatment on OHS.	Manual therapy, containing neurodynamic techniques, showed an optimal result of OHS in this group of patients with CTS.
Goyal <i>et al.</i> , 2016 [20]	n = 30	3w	Comparison: conventional physiotherapy and neural mobilization.	Neural mobilization in the CTS patients advances the motor nerve conduction and functional status.
Kocjan, 2016 [21]	n = 36	21d	Group 1: Median nerve neuro=al mobilization. Group 2: Median nerve neural mobilization with mid-carpal distraction.	Both techniques had a really good impact on the treatment of CTS. Somewhat more important improvements for the second group with the neural

				mobilization and the mid-carpal distraction.
Bartkowiak <i>et al.</i> , 2019 [23]	n = 70	2w	Ultrasonography and low-level laser with nerve and tendon gliding exercises.	Ultrasound or low-level laser together with nerve and tendon exercises may be effective for the patients with mild to moderate CTS.
Andayani <i>et al.</i> , 2020 [24]	n = 30	2w	Ultrasound and neural mobilization treatment and ultrasound and passive stretching.	Combining ultrasound therapy and neural mobilization proved to be more efficient in reducing hand disability in patients with CTS.

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