Efficacy of Sensory Rehabilitation on Pain and Hand Function in Patients with Median Nerve Entrapment

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ABSTRACT

A common Carpal tunnel syndrome (CTS) is a neuropathic entrapment for the upper limbs with middle-aged people being at higher risk. To study how sensory rehabilitation impacts pain and functional outcome of hand in carpal tunnel syndrome patients. Twenty females with CTS, aged 25-45 years were enrolled. They were allocated at random to two groups; Group I: provided for sensory rehabilitation in addition to a standard physical therapy program and Group II: received only the standard physical therapy program only. Pre and post-treatment assessment included Visual Analogue Scale (VAS) and the Boston Carpal Tunnel Syndrome Questionnaire (BCTQ). In both post-treatment groups, the decrease of mean VAS and BCTQ scores was statistically significant. No substantial difference between the two groups in the measured parameters pre or post treatment. Adding sensory rehabilitation has nearly the same efficacy as the standard physical therapy program alone in decreasing pain, enhancing hand function in mild and moderate patients with CTS.

INTRODUCTION

Carpal tunnel syndrome (CTS) is a group of symptoms caused by compression of the median nerve at the joint level of the wrist in the upper extremity (UE) (Wolny et al., 2019). Symptoms of CTS can be sensory such as numbness, tingling, and paresthesia, which may or may not be related, to the course of the median nerve of the hand. In severe cases, motor symptoms such as loss of muscle strength distally innervated by a median nerve may be present (Erickson et al., 2019).
Patients diagnosed with CTS initially present with on and off symptoms which can get worse at night or with any activity of the EU that involves repetitive movement. These symptoms usually enhance by hand splinting, repositioning, or shaking and proper positioning during sleep. During the night, splinting, shaking, or hand and arm rubbing, suggesting an ischemic origin, can also help in resolving the symptoms present (Moraska et al., 2008).

Conservative treatment includes neural mobilization of the median nerve, carpal bone mobilizations, bracing, steroid injections along with other alternative therapies. Nonetheless, the preferred approach is often surgical decompression (carpal tunnel release) when conservative treatment fails (Carlson et al., 2010; Sakr et al., 2019). Although surgical interference can decrease pain, tingling and numbness sensation, patients with severe symptoms remain with some sort of chronic sensory disturbance (Middleton and Anakwe, 2014).

Sensory re-learning (SR), is a technique used in somatosensory/sensory rehabilitation. Though well established after nerve repair as a therapeutic method (Novak and von der Heyde, 2013), many therapists (Jerosch-Herold, 2011) will not address this as part of early phase CTS retraining. In the last years, interest in this approach in the management of peripheral nerve dysfunctions has been increased (Paula et al., 2016).

This research aimed to study the effects of sensory rehabilitation on pain and hand function in patients with carpal tunnel syndromes from mild to moderate.

**Subjects and Methods**

A single-blind, randomized controlled clinical trial was conducted at the Faculty of Physical Therapy outpatient rehabilitation clinic, the University of Cairo from May to June 2019. The research has been accepted by the ethical committee of the Faculty of Physical Therapy, Cairo University, Egypt. The study had enrolled twenty female patients diagnosed with CTS. All patients signed written consent before participation to ensure complete satisfaction.

Sealed, opaque, identical envelopes randomized patients in two equal groups: group I (experimental) and group II (control). Each patient drew an envelope containing the group she was in. The number of patients in each group was 10.

Inclusion criteria were: Female patients with mild and moderate CTS who reported pain and paresthesia along with the median nerve distribution (Jablecki, 1993), age range from 25-45 years and velocity of sensory nerve Median nerve conduction across the wrist ≤ 40 milliseconds and distal sensory latency more than 3.6 milliseconds and less than four milliseconds.

Patients have been left out of the study if they had systemic disease causing CTS (i.e., rheumatoid arthritis, thyroid disease, Diabetes Mellitus), cervical radiculopathy, wrist surgery or fracture, history of carpal tunnel injection two weeks before the study, wasted thenar muscles, CTS operation, or pregnancy.

**Evaluation Procedures**

All patients were evaluated pre- and post-treatment using:

Visual Analogue Scale (VAS): is a valid and reliable measurement of pain intensity. Every patient was asked to place a mark on a 10-centimetre line, marked with words such as "no pain" and "worst imaginable pain" to indicate the level of pain level felt with 0 being "no pain" and 10 "worst imaginable pain" (Croisier et al., 2007).

Boston Carpal Tunnel Syndrome Questionnaire (BCTQ): is a measure of the severity of symptoms and hand functional status. This comprises two different scales: (1) severity of symptoms, and (2) functional state. CTS severity is assessed using 11 multiple-choice questions, which focus on pain, numbness, tingling, and nocturnal symptoms. Every item is rated between 1 (none or mild) and 5 (severe). The average of all 11 scores as the total intensity of CTS symptoms is reported. To assess eight questions assess functional status, a set of tasks. The task is graded from 1 (no difficulty) to 5 (cannot do at all). High scores in both measures suggest greater intensity or more limited hand/wrist function (Wilson and Sevier, 2003).

**Treatment Procedures**

During four consecutive weeks, treatment sessions were provided three times a week. The duration of each session was approximately one hour.

Group I (experimental group) received sensory rehabilitation program for the affected UE for 45 minutes in addition to 15 minutes of standard physical therapy program as follows:

**Sensory rehabilitation program**

Splinting for 15 minutes to maintain hand and wrist in a neutral position (Kruger et al., 1991).

Topical anaesthesia using 8% lidocaine spray for 15 minutes (Kanai et al., 2009; Algia, 2014).

Massage using different textures of material (sensory re-learning) for 15 minutes (Chu et al., 2001).
Standard physical therapy program for 15 minutes, including three groups of exercises circulatory and active free exercises, median nerve gliding and tendon gliding exercises each group for five minutes (Warren, 2001).

Circulatory and active free exercises for five minutes. The patient was seated on a chair with back support. The shoulders and neck were in a neutral position, and the forearm was supinated and flexed 90 degrees. Exercises were performed against resistance and included: wrist joint flexion, wrist joint extension, gripping, thumb opposition, forearm pronation, forearm supination and pinching of fingers. Each exercise was three sets; each set 10 repetitions, relaxation one minute in between.

Median nerve gliding exercises for five minutes. Exercises were carried out by sitting on the chair supported by the back. The shoulders and neck were in a neutral position, and the affected UE was placed in extension. The exercise steps were as follows:

Step 1: hold the joint of the wrist, flex all fingers and the thumb in a neutral position,
Step 2: hold the joint of the wrist in a neutral position with the thumb and fingers extended,
Step 3: extend the wrist joint and thumb fingers in a neutral position,
Step 4: extend the wrist joint, fingers and thumb,
Step 5: supinate the forearm while maintaining fingers and thumb extended,
Step 6: A gentle stretch is applied to the thumb by the therapist.

Tendon gliding exercises for the flexor tendons of the wrist joint and hand to gain more flexibility for five minutes. The exercises were performed by sitting on the chair supported by the back. The shoulders and neck were in a neutral position, and the forearm was supinated and flexed 90 degrees. The exercise steps were as follows:

Step 1 (straight): hold the hand midway between flexion and extension with the thumb abducted,
Step 2 (hook): flex both proximal and distal interphalangeal joints, while extending the metacarpophalangeal joints of the medial four fingers and keep the thumb adducted,
Step 3 (fist): flex both the thumb and fingers,
Step 4 (tabletop): extend both the proximal and distal interphalangeal joints, while flexing the metacarpophalangeal joints of the medial four fingers keep the thumb adducted, and
Step 5 (straight fist): flex her both metacarpophalangeal joints and proximal interphalangeal joints while an extension of distal interphalangeal joints of the medial four fingers and the thumb adducted.

During both tendon and median nerve gliding exercises, patients maintained each position for seven seconds.

Group II (control group) received the traditional therapeutic exercises including three groups of exercises: circulatory and active free exercises, Median nerve gliding and Tendon gliding exercises. For one hour, each group for 20 minutes.

Statistical analysis
The results were tested for the assumption of normality, variance homogeneity and the presence of extreme scores. Kolmogorov-Smirnov test for normality showed that demographic and clinical characteristic data, in addition to the Boston Carpal Tunnel Syndrome Questionnaire (BCTQ) and Visual Analog Scale (VAS) scores were normally distributed. Paired t-test was used to analyze demographic statistics and clinical characteristic in both groups (group I and group II) pre-treatment. MANOVA test was used for statistical analysis between and within-group comparison, pre- and post-treatment. The mean and standard deviations included descriptive statistics for demographic and clinical data, VAS and BCTQ scores. Statistical analysis was carried out using the Social Science Statistical Package (SPSS, Chicago, IL, USA) for windows, version 20 (SPSS, Inc., Chicago, IL). The p-value had been set at < 0.05.

RESULTS
In total, 20 female patients are divided into two equal groups (I and II) take part in the study Figure 1.

Characteristics of patients in both groups are represented in Table 1.

Visual Analogue Scale (VAS) scores
A significant decrease in mean VAS scores was observed in group I and II post-treatment (p=0.000, 0.007 respectively). However, no significant difference was found between both groups in pain intensity level pre- or post-treatment (P= 0.068, 0.663 respectively) Table 2.

Boston Carpal Tunnel Syndrome Questionnaire (BCTSQ) scores
A significant decrease has occurred in mean BCTSQ scores (symptom severity and functional status) in groups I and II post-treatment (p < 0.05). While th-
Figure 1: Study flow diagram

Table 1: Patient characteristics of each group

| Items               | Group (I)       | Group (II)      | t-value | P-value |
|---------------------|-----------------|-----------------|---------|---------|
| Age (year)          | 37.06 ± 13.2    | 40.06 ± 9.8     | 0.727   | 0.473   |
| MSDL (milliseconds) | 3.75 ± 0.2      | 3.77 ± 0.17     | 0.228   | 0.821   |
| MMDL (milliseconds) | 3.8 ± 0.49      | 3.49 ± 0.83     | 1.301   | 0.203   |
| MSV (meters/second) | 37.8 ± 3.6      | 38.2 ± 2.89     | 0.367   | 0.716   |

MSDL: Median nerve sensory distal latency, MMDL: Median Nerve Motor Distal Latency, MSV: Median Nerve Sensory Velocity, P: Probability value, P<0.05 = significant, P>0.05 = Non-significant

Table 2: Comparison of pre- and post-treatment mean values of VAS scores within and between groups (I and II)

| Items       | Group (I)       | Visual Analogue Scale score | Group (II)      | T-value | P-value |
|-------------|-----------------|-----------------------------|-----------------|---------|---------|
| Pre-treatment | 7.00 ± 2.15     | 5.13 ± 3.02                 |                 | 1.95    | 0.068   |
| Post-treatment | 2.60 ± 1.67     | 2.93 ± 2.18                 |                 | - 0.47  | 0.663   |
| P-value     | 0.000*          | 0.007*                      |                 |         |         |

P: Probability value, ±: standard deviation, P<0.05* = significant, P>0.05 = Non-significant
Table 3: Comparison of mean BCTSQ scores within and between pre- and post-treatment groups (I and II)

| Items                        | Boston Carpal Tunnel Syndrome Questionnaire | P-value | Pre-treatment | Post-treatment | P-value | P-value |
|------------------------------|---------------------------------------------|---------|---------------|----------------|---------|---------|
| BCTSQ symptomseverity        | Group (I)                                   | Group (II)                  | Mean difference | P-value |
| Pre-treatment                | 2.91±0.81                                   | 2.6±0.92                        | 0.313            | 0.256 |
| Post-treatment               | 1.84±0.62                                   | 1.97±0.68                        | -0.069           | 0.802 |
| P-value                      | 0.001*                                      | 0.014*                          | 0.313            | 0.256 |
| BCTSQ functionalstatus       | Group (I)                                   | Group (II)                  | Mean difference | P-value |
| Pre-treatment                | 3.03±1.05                                   | 2.57±1.2                        | 0.463            | 0.214 |
| Post-treatment               | 2±0.96                                      | 1.8±0.84                        | 0.153            | 0.679 |
| P-value                      | 0.000*                                      | 0.035*                          | 0.463            | 0.214 |

BCTSQ: Boston Carpal Tunnel Syndrome Questionnaire, P: Probability value, P<0.05 = significant, P>0.05 = Non-significant

There was no substantial difference in mean BCTSQ score between the two groups. pre- or post-treatment (P > 0.05) Table 3.

DISCUSSION

The results of the current study revealed a significant decrease in pain intensity and improvement in hand function (measured by BCTSQ) post-treatment in groups (I and II), without a significant difference between the two groups. Improvement in the group (I) agreed with (Göransson and Cederlund, 2011), who studied 39 patients experiencing hyperesthesia and found that a de-sensitization program showed significant improvement in pain and decrease in sensitive skin area size and efficiency in daily work is higher. (Challoner et al., 2019), recently reviewed clinical trials on the effect of desensitization exercises targeting areas of hypersensitivity and reported that this technique involves recalibration of afferent signals through progressive exposure of the affected area to various degrees of pressure and texture.

Improvement of both groups after treatment can primarily be related to the impact of a therapeutic exercise program, which comes in agreement with (Warren, 2001), who reported that standard physical therapy treatment is effective in the treatment of CTS symptoms. (Carlson et al., 2010) also established that treatment methods for CTS physical therapy focus on facilitating normal movement patterns.

Lack of superiority efficacy of sensory re-learning when added to the standard physical therapy program, may be explained in view that the effect of sensory re-learning depends on the ‘dose’ and intervention duration which were too low for the study to become effective. This agreed with (Jerosch-Herold et al., 2016), who reported that somatosensory rehabilitation, especially sensory re-learning, needs short but regular practice in the field of discriminatory tactile practices.

The possible explanation for the lack of impact is that it could have been too general for interference. Somatosensory rehabilitation program included several items ranging from sensory stimulation using splinting, de-sensitization, and sensory re-learning.

CONCLUSIONS

Because of the results of this study, there is no enough evidence to support adding somatosensory rehabilitation to the standard physical therapy program for patients CTS. Further research is needed on how to design effective, applicable, and affordable somatosensory rehabilitation programs. To overcome particular sensory deficits, this can require further specifically designed activities.

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Conflict of Interest
The authors declare that they have no conflict of interest for this study.

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