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Comparative Effectiveness of Low Level Laser Therapy and Nerve Gliding Exercises on Patients with Carpal Tunnel Syndrome: a Randomized Clinical Trial

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Abstract : Background and purpose: There is lack of definite evidence indicating an effective treatment for carpal tunnel syndrome (CTS). Low level laser therapy (LLLT) has long been used as one of the conservative treatments for CTS. On contrast, nerve gliding exercises have been introduced recently as a physical modality in treating patients with entrapment neuropathies. The purpse of this study was to compare the effectiveness of combining a wrist splint with either LLLT or nerve gliding exercises in treating CTS patients. **Methods:** 35 patients with mild to moderate CTS were randomized into two groups. Group(I) (18 patients underwent LLLT, and group (II) (17 patients) underwent nerve gliding exercises. All patients received a neutral wrist splint. Outcome measures included visual analogue scale (VAS); hand grip and pinch strength; sensory examiniation; Boston carpal tunnel syndrome questionnaire before and after treatment for xix weeks. **Results :** Statistical analysis revealed significant improvements in VAS, handgrip and pinch strength, and symptom severity and functional status scores after treatment as compared to group (II). **Conclusions:** The combination of LLLT with a wrist splint may be more effective than nerve gliding exercises with a wrist splint.
Keywords : Carpal tunnel syndrome, low level laser therapy, nerve gliding exercise.

Introduction

Carpal tunnel syndrome (CTS) is a peripheral neuropathy at the level of the wrist caused by compression of the median nerve within the carpal tunnel. The classical symptoms involve pain, numbness, tingling, burning, and paresthesia in the distribution of the median nerve (i.e., the thumb and the index and middle fingers) and the thenar muscle may experience atrophy [1].

Diagnosis of CTS is centered on major triads; the patient history, specific physical examination (i.e. Phalen test), and nerve conduction studies. Women are three times more affected than men in their fourth to seventh decade [2], presented with painful numbness at the median nerve course in hand and often relieved if the hand is shaked repetitively (Flick's sign) [3].

Patients with mild to moderate symptoms are treated conservatively using oral medication, local steroid injection, ultrasound therapy (UST), and paraffin bath, low-level laser therapy (LLLT), wrist splinting, therapeutic exercise [4,5]. Conversely, ultimate evidence on the best modality for treating patients with CTS is missing.

Low level laser therapy (LLLT) showed effectiveness as conservative physical therapy treatment of CTS, perhaps due to its biophysical effect which helps the neural tissue to regenerate [6]. Several studies were conducted in order to investigate the role of LLLT in peripheral nerve regeneration and functional rehabilitation post nerve injuries in rats [7,8] but less studies were done on human [9,10].

Wrist splinting in a neutral position at night has effective implication in form of pain relief [11], limiting the end-range positions that increase carpal tunnel pressures [12], and promoting adequate blood circulation along with consequent subsidence of edema [13].

Gliding exercises for the median nerve have been used to alter the length of the nerve in relation to its surrounding structures [14] and increase intraneural blood flow [15]. But the effect of neural gliding is not clear [16].

Thus, the aim of this study was to compare the effectiveness of LLLT and nerve gliding exercises in treating CTS patients.

Patients and Methods

Selection of subjects:

The study enrolled patients who met clinical and electromyography (EMG) diagnosis of mild to moderate CTS. Patients referred from Out-Patient Clinic of Kasr El Aini, Teaching Hospital, Cairo University and from the Out-Patient Clinic of Faculty of Physical Therapy, Cairo University.

Thirty-five CTS patients (31 females, 4 males) were included in the study. The inclusion criteria were: a) idiopathic CTS based on provocation tests (Carpal compression, Phalen's or Tinel's test) [17] and EMG studies; b) duration of illness was at least three months; c) the age ranged between 20-60 years.

Exclusion criteria were: a) the presence of symptoms for more than a year; b) a previous treatment of steroid injections, physical therapy or CTS surgery; c) systemic disease; d) thinner atrophy, e) peripheral neuropathy; f) other orthopedic problems affect the wrist and fingers; g) pregnancy.

After the participants received an extensive explanation about the protocol, all patients were given an informed written consent to the study approved by the ethical committee of the Faculty of Physical Therapy, Cairo University.

After an initial assessment the patients were randomly assigned into two groups using computer-generated random numbers as follows:

- Group (I): 18 patients (17 females, 1 male) were treated with low-level laser therapy (LLLT), splinting and patient education for 6 weeks, 3 sessions per week.
- Group (II): 17 patients (14 females, 3 males) were treated with neural gliding exercises, splinting and patient education for the same period as group (II).

Interventions

For Group (I):

Laser therapy was applied; a Gallium/Arsenide diode laser (GaAs) which is one of the known low level lasers that can penetrate and have its effect on tissue in the depth of 1-5cm, with a wavelength of 905nm, using a dosage (6 J/cm^2), and with 5000 Hz. The acupuncture point's exposure time was 120s for PC-7 [Daling] and PC-6 [Neiguan] [18]. The laser was positioned at an angle of 90° to the skin, according to the contact point technique. The patients were irradiated 3 times per week, for 6 weeks.

For group (II):

Nerve gliding exercises for the median nerve were designed to maximize nerve excursion while minimizing nerve strain [19]. This can be achieved by elongating the nerve bed at one joint (loading) was offset by a simultaneous movement which reduces the length of the nerve bed in an adjacent joint (unloading). In the first exercise a position of wrist extension (loading) and finger flexion (unloading) was alternated with wrist flexion

(unloading) and finger extension (loading). Likewise, the second exercise introduced to the patients was made up by counterbalance elbow flexion (unloading) with wrist extension (loading) and elbow extension (loading) with wrist flexion (unloading). The exercises were preceded by forward and backward rolling of the shoulder girdle. Ten repetitions of each exercise were performed per session. One session took approximately two minutes to complete. Patient applied these exercises by him/herself; the therapist acts only as a trainer. Patients in this group were requested to complete 10 sessions per day. All patients were instructed that exercises should not provoke any symptoms. If symptoms were provoked, it was recommended to continue the exercise regimen using a smaller range of motion.

For both groups patient education guidelines and wrist-night splinting were introduced. A patient education booklet was be written contained home and work orientation with stress in preventing activities lead to median nerve compression, in form of extreme flexion and repetitive movement handgrip. Wrist splinting was recommended to put the wrist in neutral position, aiming to reduce carpal intratunnel pressure and prevent the flexion attitude especially during night.

Outcome measures

Assessment was conducted pre and post intervention. The visual analogue scale (VAS) was used to assess level of pain and numbness (ranging from no pain/numbness to worst ever pain/numbness) [20].

Handgrip strength measurement using a Jamar® hydraulic hand dynamometer gauge (Sammons Preston Inc., Bolingbrook, IL, USA). Palmar pinch measurement using a Jamar® hydraulic pinch gauge (Sammons Preston Inc., Bolingbrook, IL, USA). The average value of three measurements was calculated, and expressed in pounds (lb).

Sensory examination was done using the Semmes-Weinstein monofilament (SWM) (SorriTM, Bauru, Brazil). A set of six nylon monofilaments of the same length were used. Each monofilament is characterized by special color and diameter: Green (0.05 g), blue (0.2 g), violet (2 g), red (4 g), orange (10 g) and magenta red (300 g). Each monofilament was applied on the palmar aspect of the distal interphangeal (DIP) zone of the index finger with the wrist in a neutral position and the patient's eyes closed. Testing was performed in a silent room. The heaviest monofilament a patient might feel was recorded. A weighted score from 1 to 6 was acquired [21].

The Boston carpal tunnel syndrome questionnaire (BCTQ) was used as a symptom severity and functional status related self-reported questionnaire [22]. The symptom severity section consists of 11 items. While the functional capacity section consists of eight items. The score for each item is between one and five. High scores reveal that symptoms are severe and decreased functional capacity [23].

Statistical analysis

In the present study, the SPSS software (Version. 19.0) was utilized for statistical analyses. All values were expressed as a mean ± standard deviation (SD). To evaluate the non-parametric measurements, the Wilcoxon signed-ranks test was used to test the difference of scores before and after treatment within each group. The Mann–Whitney U-test was used to test the difference of scores between both groups. For parametric measures, paired t-test was used to assess changes within groups and un-paired student t-test was used to assess the changes between both groups. Statistical significance was set at $p<0.05$ and considered to be two-sided.

Results

There was no statistically significant difference between the two groups in terms of age, gender, body mass index (BMI), and symptom duration ($P > 0.05$, Table 1). There was no statistically significant difference between the groups in terms of physical examination findings and symptom severity and functional capacity scores pretreatment ($P > 0.05$, Table 1).

Table 1. Demographic and baseline characteristics of the patients.

	Group I (n=18)	Group II (n=17)	p-value
	Mean±SD	Mean±SD	
Age (years)	49.5± 5.2	51.2± 7.3	0.431
Sex (F:M)	17:1	14:3	0.261
BMI (kg/m^2)	28.4±6.5	30.3±5.6	0.362
Symptom duration (months)	4.4 ± 3.2	4.2 ± 3.3	0.874
Side of involvement (right:left)	10:8	10:7	0.854
VAS (%)	59.4±17.2	64.7±20.6	0.413
Handgrip strength (lb)	46.5±19.4	47.4±10.8	0.867
Pinch strength (lb)	13.2±3.4	12.9±3.9	0.809
SWM (gm)	3.6±0.3	3.7±0.2	0.257
Symptom severity (%)	27.6±7.6	26.4±8.1	0.654
Functional capacity (%)	17.5±7.2	18.6±7.9	0.669

SD: Standard deviation; BMI: Body Mass Index; VAS: Visual analogue scale; SWM: Semmes-Weinstein monofilament; Significant level set at $p < 0.05$.

Comparing the pretreatment and post treatment measures, it was found that there was significant improvement in VAS, handgrip and pinch grip strength, and Boston CTS Questionnaire scores (symptom severity and functional capacity) in both groups. While in the SWM measures there were no statistically significant changes between the groups when compared to the pretreatment values ($p > 0.05$). The post treatment measures when compared between both groups showed statistically improvement in the VAS and Boston CTS Questionnaire scores ($p < 0.05$) in favor of the LLLT group while the remaining mean values showed no significant differences (Table 2).

Table 2. Comparison between the groups mean differences (after treatment - before treatment scores) of physical examination measures.

Variables	Group I (n=18)	Group II (n=17)	p-value
	Mean±SD	Mean±SD	
VAS (%)	-13.2±2.3 (p=0.031)^{*a}	-7.4±1.9 (p=0.043)^{*a}	<0.0001*
Handgrip strength (lb)	3.9±1.8 (p=0.037)^{*a}	4.2±2.0 (p=0.042)^{*a}	0.838
Pinch strength (lb)	1.5±0.4 (p=0.024)^{*a}	1.2±0.5 (p=0.033)^{*a}	0.549
SWM (gm)	-0.9±0.2 (p=0.477)^{a}	-0.7±0.3 (p=0.617)^{a}	0.876
Symptom severity	-5.2±2.2 (p<0.001))^{*a}	-3.9±1.8 (p=0.005)^{*a}	<0.01*
Functional capacity	-4.5±2.3 (p=0.009)^{*a}	-4.1±1.9 (p=0.044)^{*a}	0.041*

SD: Standard deviation; BMI: Body Mass Index; VAS: Visual analogue scale; SWM: Semmes-Weinstein monofilament; * Significant at $p < 0.05$; ^{a} Paired t-test.

Discussion

Carpal tunnel syndrome (CTS) should be initially treated conservative. Several authors declared that nonsurgical methods are ineffective, while others stated that physical modalities could treat patients with CTS successfully and assist recovery such as ultrasound [4], pulsed magnetic field [10], paraffin therapy [24], low level laser therapy [25], exercises [14,16] or splints [11].

In this study, the LLLT tends to be more effective than nerve gliding exercises in treating CTS patients if accompanied with wrist splinting. Even all patients who underwent LLLT or nerve gliding showed changes in all parameters except sensory perception which were not significant.

This study revealed that low-level laser improves handgrip and pinch strength, VAS scores, and Boston CTS questionnaire either the symptom severity or functional capacity for mild to moderate CTS.

The effect of laser in pain and inflammation control is well studied. The effect of low energy laser is not thermal, instead, it is supposed to facilitate microcirculation and endorphin secretion, in addition hinder the enzymes that block pain enzymes leading to reduce pain and inflammation [26,27,28]. Also the nerve gliding group showed improvement in pain relieving and increase in handgrip and pinch strength these can be attributed to stretching adhesions, increasing the space between the the transverse carpal ligament and median nerve, and by reducing the compression and edema within the carpal tunnel [14,16,19].

In the current study, neutral position splinting was applied in the LLLT and nerve gliding groups leaded to improvement in patients with CTS. Splinting used to reduce repetitive wrist movement and to promote healing of irritated nerve by supporting the effects of the treatment modalities [11,29].

Conclusions

It is suggested that the LLLT may be more effective than nerve gliding exercises if they are accompanied by wrist splinting and patient education in cases of mild to moderate CTS.

Limitations

The application of a splint in the study would influence the results. The effect of a splint on CTS might embarrass the power of the modalities used. The immediate effects of the physical modalities were examined in the present study and further clinical trials including large numbers of patients are recommended to test the long-term effects of these methods.

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