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Effect of High Power Laser on Physiological Findings of Median Nerve in Pregnant Women with Carpal Tunnel Syndrome

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Abstract

Background: Pregnant women frequently suffer from carpal tunnel syndrome, a common neuropathy. Investigating the effects of high-power lasers on pain and the electrical properties of the median nerve in pregnant women with carpal tunnel syndrome was the aim of this investigation.

Methods: Using clinical provocative tests (the Tinel and Phalen tests), thirty pregnant women with mild to moderate Carpal Tunnel Syndrome (CTS) who were between the ages of 20 and 35 were the subjects of this prospective, randomised controlled experiment. The exclusion criteria included cardiovascular disorders, hypertension, diabetes, gestational diabetes, thoracic outlet syndrome, cervical disc prolapse, cervical spondylosis, and other conditions. Patients with carpal tunnel syndrome who had surgery were categorized into two groups; group A consisted of those who had been diagnosed with CTS prior to pregnancy and received both high power laser treatment and standard physical therapy in the form of tendon gliding exercises, whereas group B only received standard physical therapy. Both groups were instructed to wear a cock-up splint during the nighttime.

Results: The study's findings indicated a substantial enhancement in finger pinch strength and nerve conduction speed in both groups following the treatment. A comparison between the two groups revealed a statistically significant difference in favour of group (A).

Conclusions: The high-power laser therapy appears effective noninvasive treatment option for pregnant women with CTS, providing pain relief and improving nerve conduction parameters.

Keywords: High Power Laser, Median Nerve, Carpal Tunnel Syndrome

1. Introduction:

Pregnant women frequently suffer from carpal tunnel syndrome (CTS), the most common kind of entrapment neuropathy. In addition to causing hand discomfort and affecting daily chores, it might result in occupational disability. The primary cause of CTS is compression of the median nerve in the carpal tunnel, which produces symptoms affecting sensory and motor function, notably in the thumb, index, and middle fingers. These sensations usually intensify at night and wake patients up in the middle of the night [1].

The chance of developing CTS can be increased by rheumatoid arthritis, diabetes, hypothyroidism, polyneuropathies, pregnancy, and other hormonal changes. A physical examination and nerve conduction tests (NCS), which gauge the severity of its stage, are used to diagnose CTS because the enlargement of structures within the canal results in elevated pressure at the carpal tunnel [2]. One common pregnancy issue is CTS. Although the precise incidence rate is unknown, it has been reported to be as high as 62% and usually appears in the third trimester, however it can also appear in the first or second [3].

The primary treatment options in carpal tunnel syndrome are conservative methods, encompassing anti-inflammatory medications, physical therapy, splinting, and steroid injections. Surgical decompression is typically considered for patients with severe and difficult-to-treat cases. In some cases, medications did not provide any additional benefits over a placebo in alleviating the symptoms [4].

The diagnosis of CTS is typically confirmed through a combination of a patient's medical history and a comprehensive physical examination, which is further supported by additional tests like electroneuromyography. The condition primarily affects women in their 40s to 70s, resulting in painful numbness along the path of the median nerve, which is often alleviated by repeatedly shaking the hands (Flick's sign) [5].

For patients with CTS who experience mild to moderate symptoms, conservative management is often provided as an option and may decrease the number of patients requiring surgical treatment. Surgical intervention is often required for severe cases that do not improve with initial treatment or for long-standing conditions that have progressed [6].

On the other hand, the majority of non-invasive therapies for CTS are backed by few and poor quality data, and any clinical improvements that do happen usually last for a short time, according to Cochrane systematic reviews [7].

Results from laser therapy suggest a favorable outcome in the restoration of peripheral nerves in cases of both sensory and motor nerve damage, achieved through both local and overall effects [8].

High-intensity laser therapy has physiological effects that increase the activity of many intracellular enzymes, especially those involved in DNA synthesis promotion, the Krebs cycle, sodium/potassium membrane pump activation, increased fibroblast activity, and oxygen transport stimulation [9]. This study sought to show how high-power lasers affected the electrical characteristics of the median nerve and pain in females suffering from carpal tunnel syndrome.

2. Methodology:

2.1. Subjects and methods

This prospective, randomized controlled trial was conducted on 30 pregnant women between 20 and 35 years old, with mild to moderate CTS identified by a doctor chosen from neurology departments at Kafr El-Shaikh University Hospital, as confirmed by a neurology specialist.

Clinical testing for carpal tunnel syndrome (CTS) showed positive Tinel and Phalen test findings, and patients complained of numbness and paraesthesia in the median nerve-affected regions. The Ethical Committee of Kafr El-Sheikh University's Faculty of Physical Therapy granted previous clearance for the study, which was carried out with approval code P.T/WH/2/2023/37. After being informed, the patients gave their consent. Patients with thoracic outlet syndrome, cervical disc prolapse, cervical spondylosis, diabetes, gestational diabetes, cardiovascular disease, hypertension, carpal tunnel release surgery, or pre-pregnancy CTS were excluded from the study.

Randomization

In order to prevent selection bias, two wrapped cards that represented the two therapy groups were chosen at random by the patients using a simple random method. These cards are as follows:

Group A received both a high-power laser and traditional physical therapy.

Group B got routine physical therapy treatments.

A comprehensive history was taken from all patients, and they underwent a thorough clinical examination of their rheumatological and neurological systems.

A total of forty-five individuals were initially screened for participation in the trial, with nine later found ineligible and six declining to participate. The remaining patients were divided into two equal groups of 15 each. The assigned patients were then monitored, and their data was statistically analysed. **Figure 1**

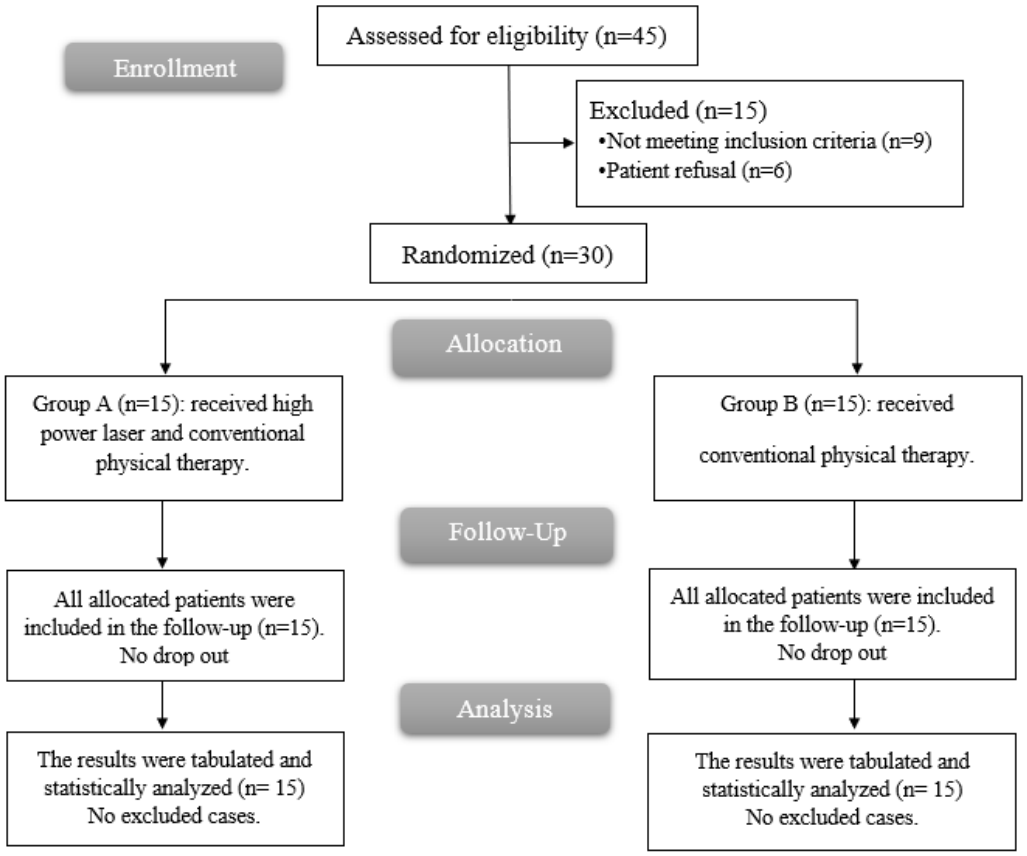

Figure 1: Flowchart of the enrolled patients

2.2. Evaluating methods

The Visual Analog Scale (VAS) was employed for pain assessment. The patient is asked to identify a point on the line that reflects their current level of pain. The distance from a point of no pain to where the patient is reporting pain is being measured. A measurement taken to indicate the level of pain experienced by the patient [10].

Electrophysiological myograph (EMG) TruTrace EMG Surface Electrode measure sensory carpal tunnel (S.C.T).in which Sever carpal tunnel (S.C.T 3.6ms), (mild 0.7ms), (moderate 0.8ms), and motor distal latency(4.2ms), and more than 4.2ms is very sever carpal tunnel. As advised by the American Association of Electrodiagnostic Medicine (2002), a nerve conduction study (NCS) of the median nerves was used to determine the motor amplitude and conduction velocity of the median nerve.

Treatment instrument:

Patients in group A was subjected to high laser power using a double diode laser device (LUMIX® 2 device, Fisioline, Italy) emitting at(904nm), frequency(40KHZ), source pow(300w) Energy(900.0JOUL) Duty cycle (50%) was applied on the course of median nerve.

2.4Treatment procedure: Group A Patients was subjected to high laser power using a double diode laser device, not allowed to take any analgesics during the whole period of the study. Patient in sitting position with hand supported. Therapist position: In front of patients. Both therapist and patient wear safety goggles, told her not to move after the device is turned on. The laser probe was applied perpendicularly to the median nerve's course through the carpal tunnel, from a point approximately 10 cm proximal to this area, which was then divided into three sections. The duration for each point was 120 seconds, and the total session time was 10 minutes, including conventional therapy methods, such as wearing a cock-up splint and performing tendon gliding exercises, which involved finger positions including down, fist, L, and fingers to palm.

The tendon gliding exercise involves the fingers down position, which is demonstrated by the hand with fingers bent downwards. To accomplish this, slowly curl each finger so that the joints are bent and the fingertips make contact with the finger pads at their base. She could have some wrist or finger strain. Return to the initial open-hand position after holding this position for two to three seconds. Apply a small amount of pressure and gradually contract your hand into a tight fist from the original open-hand beginning posture. There should be no pain during this event. Before switching back to an open-handed stance, hold this position for two to three seconds [1].

Show the "L" posture with your hand, then slowly bend the fingers forward while keeping the knuckles straight. Only the wrist, where her fingers meet the hand, should flex. Her hand should now make a "L" shape. Maintain this position for a duration of two to three seconds before reverting to the initial position [1].

Bend her fingers just at the first and middle joints. Her fingertips should be softly pressed against the palm. Maintain this stance for two to three seconds before returning to the initial open-handed position. Perform the tendon glides series 5 to 10 times, two to three times daily, to alleviate symptoms and prevent potential issues with carpal tunnel syndrome (CTS) [1].

Group B: received conventional physical therapy only as in group A.

All patients in both groups were advised to wear cock-up splint of night.

2.2. Statistical analysis

The SPSS v26 program, created by Chicago, Illinois-based IBM Inc., was used to analyse the data. Standard deviations (SD) and mean values were used to quantitatively quantify the variables, and an unpaired The Student's t-test was performed to compare the two groups. The qualitative variables were represented by frequencies and percentages, and the statistical analysis was carried out with the Chi-square test or Fisher's exact test, as appropriate. The two-tailed P value less than 0.05 was judged statistically significant.

Results:

Age and anthropometric data were insignificantly different between both groups. **Table 1**

Table 1: Comparison of age and anthropometric data between both groups

	Group A (n=15)	Group B (n=15)	T. value	P
Age	30.33 ± 4.15	29.8 ± 4.84	0.324	0.748
Weight (Kg)	71.73 ± 6.63	74.57 ± 5.08	1.313	0.200
Height (cm)	163 ± 4.96	163.87 ± 5.1	0.472	0.641
BMI (kg/m^2)	26.96 ± 1.49	27.78 ± 1.58	1.464	0.154

Data are presented as mean ± SD or frequency (%). BMI: Body mass index.

A significant difference was observed in post-treatment VAS pain, VAS paraesthesia, finger pinch strength, and nerve conduction velocity compared to pretreatment levels within both groups, with a statistically significant result of $P < 0.001$. Table 2

Comparing Data Across Different Groups

Prior to the treatment, there was no notable disparity in the duration of CTS, VAS pain assessment, VAS paraesthesia ratings, finger pinch strength measurements, and nerve conduction velocity readings between the two groups. Following the treatment, a statistically significant difference was observed in VAS pain, VAS paraesthesia, finger pinch strength, and nerve conduction velocity between the two groups, with a p-value of less than 0.05, indicating a favorable outcome for group A.

Table 2: Comparison of all dependent variables at different measuring periods among groups

		Group (A) (n =15)	Group (B) (n =15)	P
Duration of CTS		2.07 ± 1.1	2.2 ± 1.08	0.744
VAS pain	**Pretreatment**	8.73 ± 1.39	8.53 ± 1.25	0.595
	Post treatment	3.13 ± 1.96	5 ± 2.27	**0.041***
	P. value**	**<0.001***	**<0.001***	
VAS paresthesia	**Pretreatment**	8.33 ± 1.5	8.13 ± 1.46	0.683
	Post treatment	3 ± 1.85	4.73 ± 2.22	**0.037***
	P. value**	**<0.001***	**<0.001***	
Finger pinch strength	**Pretreatment**	4.21 ± 1.13	4.31 ± 1.09	0.807
	Post treatment	9.14 ± 1.68	7.49 ± 1.31	**0.006***
	P. value**	**<0.001***	**<0.001***	
Nerve conduction velocity	**Pretreatment**	43.15 ± 3.48	43.54 ± 3.32	0.758
	Post treatment	52.15 ± 1.48	47.57 ± 1.89	**<0.001***
	P. value**	**<0.001***	**< 0.001***	

Data are presented as mean ± SD. * Significant p value <0.05, ** intra-group comparison of the results pre- and post-treatment, VAS: visual analogue scale, CTS: Carpal tunnel syndrome.

3. Discussion

Carpal tunnel syndrome often affects the supply region of the median nerve, which includes the first three fingers and the outside portion of the fourth digit. Common symptoms include pain, numbness, and tingling [11]. Physiotherapy treatments including electrotherapeutic and therapeutic modalities have been suggested as options for managing CTS. Different treatments for CTS have unique theoretical underpinnings, yet all share the ultimate goal of alleviating pain and enhancing functionality; the array of available treatment options implies that the most effective approach remains unclear, necessitating further research to identify the best course of treatment for individuals with CTS [12].

The study found a substantial variation in pain VAS scores after treatment, with group A experiencing more favourable outcomes. The VAS paraesthesia reported after treatment differed significantly between the two groups under examination, with group A demonstrating a preference. The findings are congruent with those of Shady et al. [13], who found that the HPLT group had considerably lower VAS ratings than the control group.

The concept can be attributed to HPLT, which operates by suppressing pain signals at various stages. Histamine and bradykinin release from wounded tissues is reduced at the tissue level, and there is also an increased pain threshold. Additionally, substance P released from peripheral pain receptors is decreased by laser therapy, which heightens the sensitivity of pain-transmitting neurones and leads to the development of hyperalgesia, or enhanced pain sensitivity.

In peripheral nerves, laser therapy could potentially slow down the transmission of pain signals by inhibiting the transmission of signals through Aδ and C fibers. In addition, laser treatments boost the release of naturally produced opioids, such as beta-endorphin, which suppress pain in the central nervous system [14]. Laser therapy can indirectly relieve pain by boosting blood flow through the tissue due to increased nitric oxide levels, which enlarges the arteries and capillaries, facilitates ion exchange within the cell, raises oxygen intake, and promotes nucleic acid and protein production [15].

The reduction in pain is particularly important, as it demonstrates that both interventions were able to alleviate one of the most bothersome symptoms of CTS. Similarly, the improvement in VAS paraesthesia indicates that both treatments were successful in reducing abnormal sensations, such as tingling and numbness, which are common in CTS due to nerve compression. Our study's findings demonstrated a considerable influence on electrophysiological parameters, which is consistent with AshourAA's (16) suggestion that these therapies helped to lower the pressure on the median nerve, hence enhancing both motor and sensory function. Interestingly, the group receiving HILT in combination with conventional therapy (Group A) showed greater improvements, suggesting that the addition of laser therapy may provide a more comprehensive therapeutic benefit, potentially accelerating recovery and symptom relief compared to conventional therapy alone [16].

The median nerve's electrophysiological characteristics in CTS are mainly evaluated through NCS, which gauge the electrical impulses' amplitude and speed as they travel through the nerve. Conduction velocity is delayed in CTS due to compression of the median nerve inside the carpal tunnel, diminished sensory and motor nerve responses, and occasionally, complete nerve blockage. These alterations are apparent in reduced sensory nerve action potential (SNAP) velocities as well as decreased motor nerve conduction velocity (MNCV), reflecting impaired nerve function. HILT may help improve these electrophysiological measures by reducing inflammation and pressure on the nerve, thereby potentially enhancing nerve conduction and overall nerve function [17].

The results of the study confirmed the findings of Rayegani et al.'s [18] investigation by demonstrating that individuals in group A had a considerably higher pinch strength than those in group B, which showed that the HPL group had the highest mean pinch strength, weighing 11.93 kg at the initial assessment and 12.12 kg 12 weeks after treatment; on the other hand, the control group had the lowest mean strength at both the initial assessment and 12 weeks after treatment. Casale et al. [19] found that patients showed a notable improvement in their functional capacity after treatment, with the most impressive results observed 12 weeks post-treatment, with the high-protein-low-calorie diet group having the best outcomes.

The improvements observed in Group B, including pain reduction, enhanced nerve conduction velocity NCV, and improved EMG activity, were achieved through the application of conventional physical therapy alone. The underlying pathology of CTS is adequately addressed by conventional treatment, which includes therapies like nerve and tendon gliding exercises and wrist splinting. By enhancing wrist alignment and lowering carpal tunnel inflammation, these techniques lessen the strain on the median nerve. Additionally, the enhanced local circulation resulting from these interventions promotes tissue healing, which is critical for reducing pain and alleviating symptoms associated with nerve compression [20].

Conventional therapy also plays a significant role in restoring physiological function. By alleviating mechanical compression of the median nerve, nerve conduction velocity is improved, allowing for better transmission of sensory and motor signals [21]. This directly translates into functional recovery and symptom relief. Moreover, the improved nerve function enhances EMG activity, as it restores adequate neural input to the muscles innervated by the median nerve, preventing muscle atrophy and improving muscle activation [22].

The study's limitations were the relatively small sample size. Only one centre was used for the investigation.

Conclusions:

The high-power laser therapy appears effective noninvasive treatment option for pregnant women with CTS, providing symptomatic relief and improving nerve conduction parameters. **Financial support and sponsorship:** Nil

Conflict of Interest: Nil

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