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A Multimodal approach of electrotherapy versus nerve flossing technique in patients with chronic carpal tunnel syndrome: a randomized controlled trial

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ABSTRACT

Background: The median nerve becomes trapped at the level of the wrist in the condition known as carpal tunnel syndrome (CTS), which has a substantial impact on hand functions. Objectives: To assess the impact of the multimodal electrotherapy and nerve flossing technique on patients with chronic CTS on pain intensity, pinch grip power, hand function status, symptom severity, and sensory and motor distal lantenies

Design: A randomized controlled trial conducted in a single-blind technique.

Methods: In this study, 51 female cases, aged 30-45, with unilateral mild to moderate CTS in their dominant hand took part. They were divided into three groups at random. Cases in Group A (the experimental group, n = 17) underwent multimodal electrotherapy (low-level laser therapy, interferential therapy, and ultrasound) plus conventional therapy, including a splint and therapeutic exercises. Cases in Group B (the experimental group, n = 17) obtained median nerve flossing in addition to conventional therapy. Cases in Group C (the control group, n = 17) got typical rehabilitative exercises and wore a splint. Every treatment session took place three days a week for eight weeks. Measurements were taken to compare the results before and after the treatment.

Outcome measures: A visual analog pain scale was utilized to assess pain level, a baseline hydraulic pinch dynamometer was used to measure pinch power, hand function status, and symptom severity using the Boston Carpal Tunnel Questionnaire, and electromyography was used to measure the median nerve's sensory and motor distal latencies.

Results: There was no significant difference between the effects of the multimodal electrotherapy approach (group A) and the median nerve flossing technique (group B) on pain intensity level, pinch grip strength, hand function status, symptom severity, sensory, and motor distal latencies. However, these turned out to be more effective than traditional therapeutic exercises (Group C).

Conclusions: In accordance with the outcomes of the current study, patients with chronic CTS respond well to the multimodal electrotherapy method and the median nerve flossing technique.

Keywords: *multimodal approach, nerve flossing technique, carpal tunnel syndrome*

INTRODUCTION

One of the most common upper limb entrapment neuropathies is carpal tunnel syndrome (CTS), which primarily affects adult females [1] and is brought on by compression of the median nerve at the level of the carpal tunnel (CT) [2]. Because of its high prevalence and significant financial consequences, CTS is anticipated to impact 3-6% of the general population between the ages of 30 and 60. This provides a challenge for healthcare providers. Women are three times more prevalent than males to have CTS, with a prevalence rate of 9.2% in women and 6.6% in men [3].

Pain, numbness in the first three fingers and on the radial side of the ring finger, reduced hand motor function due to thenar muscle weakness, and, in more severe cases, axonal sensory loss is some of the clinical indications of CTS. Significant limitations in everyday activities and job performance are frequently linked to CTS [4]. The majority of CTS cases are idiopathic, however repetitive hand movements or prolonged, improper wrist postures at work significantly increase the risk of CTS [5]. Diabetes mellitus, obesity, hypothyroidism, pregnancy, and rheumatoid arthritis are additional risk factors [6].

Mechanical trauma, increased tunnel pressure, a smaller tunnel diameter, decreased blood flow to the nerve, delayed venous return, and protracted ischemia are all factors that contribute to the pathophysiology of CTS. These factors may impair the nerve's flexibility and gliding ability, which may result in axonal damage and nerve dysfunction[7]. The diagnosis of CTS is primarily based on the physical examination and medical history.The physical exam combined with nerve conduction tests (NCS) are effective ways to confirm the diagnosis of CTS identify the dysfunction of the median nerve and determine the degree and severity of the disease [8, 9].

According to Mallik and Weir [10], who claimed that NCS could be used for peripheral neuropathy as a gold-standard evaluative method because of its objectivity in providing information on the nerve condition throughout the entire body, NCS of the median nerve is considered a valid and reliable assessment method. According to empirical data, many mild-to-moderate CTS patients benefit from conservative, non-operative therapy. Although many individuals with mild to moderate CTS benefit from a variety of traditional, non-surgical therapy, there is still no consensus on the best method for managing CTS. Rest, physical behavior modification, splinting, electrotherapy, laser, ultrasound, manual therapy techniques, gliding exercises, and stretching exercises are all management modalities for CTS. These many techniques could lessen the number of cases undergoing surgical interventions [11,12].

Multimodal therapy involves two or more physical techniques during the same treatment session since recent research has shown that combining therapies has a greater clinical benefit than employing a single treatment alone. According to a spectrum of studies, combined physiotherapy treatments include both active and passive modalities, including physical activity, manual therapy, or other electrotherapy modalities. Due to the various roles played by these modalities, which can improve functional activities, improve nerve swelling, pain intensity, and inflammation, and enhance quality neurological performance in the shortest amount of time possible, the cases receive a combination of these modalities, and the outcomes may be better compared to one modality [13, 14].

On another level, several studies are now concentrating on the mechanical structures around the median nerve at the wrist and reestablishing equilibrium around the neurological structures in order to cure mild to moderate CTS. Hence, the nerve flossing method

(NFT) is a therapeutic intervention that seeks to reestablish equilibrium inside and around the neurological system. It has been suggested as an effective treatment for nerve entrapment because it enables decreased neural tissue intrinsic pressures, which advances appropriate physiological functions. It also improves the nerve's regular gliding movements, nutrition, and circulation through increased neural vascularity, decreased nerve adherence, and dispersion of noxious fluids [15, 16].

NFT, often known as the "slider technique", is one of the two popular varieties of neurodynamic operations that are carried out in a controlled, stepwise manner. NFT is a series of aggressive mobilizations intended to gradually realign inflamed nerves. It is an alternation of two joints moving in synchronous motions, one of which lengthens the neural bed and causes tension in the nerve, and the other of which shortens the neural bed. The second type of neurodynamic technique is the "tensioner technique," which relies on tugging from both ends of the nerve. This technique is comparable to extending one end of a cord while leaving the other end loose and then changing the direction of the chord [17, 18].

In contrast to the neural tensioner technique, which prioritizes the epineurium, NFT focuses on active nerve mobilization, which lowers the pressure in the perineurium and endoneurium. This, according to a preliminary study, makes NFT more successful than the neural tensioner approach. As a result, NFT is intended to cure pain by lowering supraspinal sensitization, removing interneural edema, boosting nerve excursion, improving blood flow to the nerve, enabling venous return, and limiting ischemic discomfort. Each outcome revealed the normal mechanical characteristics of the nerve, reducing discomfort and enhancing nerve function [19].

Consequentially, the lack of high-powered trials comparing the effects of the multimodal approach of electrotherapy and median NFT on pain intensity level, pinch grip strength, hand function status scale (FSS), the severity of symptom scale (SSS), distal sensory latency (SDL), and motor distal latency (MDL) of the median nerve in patients with chronic CTS is the driving force behind the need for this study. Also, the outcomes of the multimodal strategy of electrotherapy and median NFT in patients with chronic CTS have not been compared in any previous studies. So, the purpose of the current study was to determine if the efficacy of multimodal electrotherapy and median NFT differed in subjects with chronic CTS.

MATERIAL AND METHODS

Study design

A prospective, randomized, single-blind, controlled trial including pre- and post-testing was used in the investigation. Before the study got started, ethical approval was acquired from the Faculty of Physical Therapy's institutional review board (P.T. REC/012/003407). The Declaration of Helsinki's Principles for the Conduct of Human Research was observed during the study. In the Clinical Trials.gov PRS Registry, the current study has been documented (NCTO5164237). Every patient has given their voluntarily given their signed, informed consent. Between November 2021 and December 2022, the study was carried out at the outpatient physiotherapy clinic of the October 6 University Hospital.

Subjects

From the Neurologic Outpatient Clinic at the October 6 University Hospital in Cairo, Egypt, 51 female cases were enrolled in the current study. The following elements were encompassed by the inclusion criteria: A physician diagnosed the cases with unilateral mild to moderate CTS in their dominant hand in accordance with the most recent recommendations of the American Society of Electrodiagnostic Medicine(2) age ranged between 30 and 45 years old; (3) patients with a body mass index ranged from 18.5 and 24.9 kg/m2.. (4) SDL of the median nerve is greater than 3.5 ms, but less than 3.9 ms, and MDL is greater than 4 ms but less than 4.5 ms; and (5) positive clinical manifestations (pain, paresthesias in the distribution of the median nerve, positive Tinel's sign, and Phalen's sign. The cases with diabetes type 1 or 2, hypertension, thyroid disease, thoracic outlet syndrome, renal disease, rheumatological

disorders,cerebrovascular disease, and cardiovascular disorders cervical radiculopathy, polyneuropathy, a steroid injection into the carpal tunnel, patients suffering from wrist arthritis, wrist fractures, or acute trauma, pregnant women were excluded from this study.

Sample size calculation: G*POWER statistical software (version 3.1.9.4; Franz Faul, University at Kiel, Germany) [F tests- ANOVA, =0.05, =0.2, effect size = 0.4] was adopted in the current academic trial to gauge sample size in order to prevent type II error. It has been found that N=51 was the right number of participants for this investigation. This idea is supported by earlier analysis of the findings from the earlier study.

Randomization

Each case in the study has obtained all the needed information about the nature, goals, and advantages of the study, as well as their right to decline or withdraw at any time, besides the confidentiality of the gathered data. The cases were randomly subcategorized into three equal groups using a computer-based randomization program: a control group and two study groups. No case has left the trial following the randomization. They were not told which group they were placed in. The procedures were done carefully and successfully.

Interventions

The cases were randomly allocated to three groups. First, Group A is composed of 17 cases who obtained a multimodal approach of electrotherapy (low-level laser therapy [LLLT], interferential therapy [IFT], ultrasound [US], and a non-guideline approach in the form of a splint and therapeutic exercise) for 8 weeks. Second, Group B encompasses 17 cases receiving nerve flossing technique (NFT) and conventional physical therapy modalities in the form of splints and therapeutic exercises for 8 weeks. Third, Group C is a set of 17 cases who got conventional physical therapy modalities only (splints and therapeutic exercises) also for 8 weeks.

Low-level laser therapy

Group (A) received LLLT by an I.R. laser with two synchronized sources (laser diodes) (808 nm in continuous emission, 905 nm in pulsed emission), with a peak power output of 1100 MW and a frequency of 1000 Hz. It used LLLT by the Multiwave Locked System MLS Laser Therapy type M6 (ASA Srl, Vicenza, Italy) to a depth of 3–4 cm by the pointer method. A 1-cm-diameter laser probe was positioned directly and perpendicularly on five sites along the median nerve as it traveled 10 cm over the palmar surface of the wrist. The MLS laser therapy (laser M6, ASA) parameters were as follows: intensity 100%, frequency 1000 Hz, dose for each point was 6 J/cm2, totaling 30 J for 5 points, and exposure period was 10 min (2 min per point) per day, three times per week, for 24 sessions in eight weeks. Every session involved the patient and the therapist donning safety eyewear [20].

Interferential therapy

Group A got interferential current modalities by using Enraf-Nonius (ENDOMED 484, Germany) equipment. The patients were supine and comfortably positioned on the treatment table, with an extended elbow and wrist and the volar aspect of their hands looking upward. Four electrodes were positioned: two on the volar aspect of the forearm's last third, a second pair on the palmar region of the hand, and the fourth electrode on the thenar region. The electrode size is 3 x 3 cm, and adhesive pads are used to facilitate IFC conduction [21]. The electrode pairs were placed at a distance of at least 2.5 cm from each other. The utilized parameters were a base frequency of 4,000 Hz, a modulation frequency range of 10 Hz–20 Hz, spectrum mode (triangular Δ), and slope 1/1 in a quadripolar manner with a beat frequency of 80 Hz. IFC therapy was conducted for 24 sessions (3 sessions per week for 8 weeks), each lasting 20 minutes.

Ultrasound therapy

The cases in Group A have obtained the therapeutic US.utilizing the EMS Physio (EMS 3601) device. It was applied perpendicularly with a circular pattern of slow movement of the

head of the US and a transducer area of 4 cm2, using aquasonic gel as the couplant, while the wrist was in the neutral position, supinated, relaxed, and well supported. The following parameters were used: an intensity of 1.0 W/cm2 at a 1 MHz frequency and pulsed (25%) ultrasound waves with a pulsed mode of (1:4), US therapy was applied for 5 min/session. The total treatment was 24 sessions (3 days per week for a total of 8 weeks) [22].

Nerve flossing technique

Group B received both NFT and conventional therapy. Before the treatment course began,. NFT was presented by the physiotherapist and then performed by the patient with the supervision of the therapist [23]. First step First step: This technique was carried out while seated, with the forearm in the mid position, the elbow flexed 90 degrees, the arm abducted 90 degrees, and the head in a neutral posture. Second step: The patient's elbow is extended by the therapist, who then orders them to bend their heads to the same side while extending and abducting their wrists and fingers [23]. Thereafter, while maintaining an extended elbow, alternate movements were made between the wrist and head positions. Hence, the head bowed to the opposite side when the wrist was flexed, and vice versa. The head bowed to the same side as the wrist as it was extended downward. Third step: The patient's head was tilted to the opposite side while the elbow and wrist were flexed. In each position, NFT was carried out ten times throughout a session, with a 5-second hold and a 60-second rest period in between each repetition [24]. During eight weeks, three days a week, once every day, conventional exercises were administered as in Group A after 2 minutes of NFT rest.

Non-guideline approach

For eight weeks, three sessions each week, all cases in the three groups got the following non-guideline stretching and strengthening treatment: they were instructed to wear a neutral wrist splint, which was a custom-made volar surface thermoplastic wrist splint that was placed on the palmar surface of the injured wrist. During eight weeks, the cases had to strictly wear the orthosis. The splint was made to allow full movement of the metacarpophalangeal joints by covering the distal third of the forearm and the distal half of the palmar region [25].

On one level, the therapist massaged the palmar region of the hand in a circular motion and in a longitudinal direction on the forearm for five minutes while the case was seated, the elbow slightly flexed, and the wrist supinated [26]. Stretching exercises for the TCL and wrist flexors: The palms of the cases' arms, which were raised in front of them, facing the ceiling. Once they felt a light to moderate strain in their forearm, they bent their wrist while pointing the other hand (the sound side) towards the ground. For at least 15 to 30 seconds, the case is guided to maintain this posture and to repeat each session 2-4 times, 3 times weekly for 8 weeks.

On another level, Thenar and first, and second lumbrical muscles were used in the strengthening exercise. Prior to being asked to squeeze a ball, the cases were seated and handed a ball (hand grip exercise). Pincer grip exercise: the cases were guided to grasp a small ball, pinch it between their index finger and thumb, and then release it. This exercise targets the first and second lumbrical muscles. The case was guided to hold for 10 seconds, then relax, with (5:10) repetitions for each exercise. This exercise can aid with hand dexterity.

Wist distraction

The patients were guided to position their forearm on the treatment table and their hand outside the table while sitting in a chair. The other therapist's hand pushed the carpal bone away from the patient as the therapist supported the patient at the distal radial styloid process. Each exercise was performed 3–5 times during each session. Carpal gliding was performed in the same position as wrist distraction, with the therapist's hand gripping the distal radial styloid process and the other hand manipulating the scaphoid bone in an anteroposterior direction on the radius with an oscillation of 30–40 per minute [27].

Patient education

Avoiding excessive wrist flexion and extension, hard clutches, not holding or carrying objects for extended periods of time, avoiding catching with fingers, avoiding repetitive hand and wrist motions like knitting or sewing, and supporting the wrists while performing an activity are all preventative measures.

Outcome measures

Visual analog scale: The subjective pain level was described using the visual analog scale (VAS), a calibrated scale on which the cases could indicate their rating along a 10- cm line. The scale ranges from 0 to 10, with 0 representing no pain and 10 denoting unbearable pain. The cases were given instructions to record how much discomfort they were feeling. Before and after the treatment, it was done for every case in the three study groups [28].

Grip strength: The same researcher measured hand grip power (measured in kilograms). A baseline hydraulic dynamometer was used to measure grip strength in accordance with the recommendations of the American Association of Hand Therapists [29]. The forearm was in a neutral position, resting on a table, and the patient was seated with the elbow being tested flexed around 90 degrees. The patient was guided to squeeze as hard as they could with the dynamometer between the tip of the thumb and tip of the index finger, which is known as a "tip to tip pinch," and then to insert the pinch meter between the radial side of the index finger and the thumb, which is known as a "key pinch." The patient was told to squeeze as firmly as possible. With a 30-second gap between each experiment, this technique was done three times. The three trials' average scores were computed.

Boston Carpal Tunnel Questionnaire: Cases with CTS self-completed the Boston Carpal Tunnel Questionnaire (BCTQ), which assessed the functional status and the intensity of symptoms. The BCTQ had good validity, reliability, and responsiveness [30]. Two scales were adopted in the questionnaire: the FSS, which has 8 items and describes how the syndrome impacts daily life and the degrees of difficulty in routine activities; and the SSS, which has 11 items and assesses symptoms for severity, frequency, and timing. The average scores for each subscale ranged from 1 to 5. On a scale from 1 (no trouble) to 5 (extreme difficulty), The final score was determined by dividing the total scores by the number of items. While A lower functional ability and more severe symptoms were indicated by a higher score. [31]. For three groups, this questionnaire was administered both before and after treatment.

Electrophysiological studies: An instrument was Neuropack S1 MEB-9004. Nihon Koden (Japan) was used to measure the NCS of the median nerve. The temperature in the room was kept at 25 °C. [32]. The active surface recording electrode for the motor conduction experiments was placed on the abductor pollicis brevis muscle, while the reference electrode was positioned over the first metacarpal-phalangeal joint. For the distal segment stimulation, on the other hand, the stimulating electrodes were positioned at the wrist close to the CT, and the ground electrode location between the recording and the stimulation was near the wrist creases. From the beginning of the stimulating artifact to the beginning of the compound muscle action potential, MDL was measured. To eliminate lesions of the median nerve, such as polyneuropathy, the NCV was also calculated[33].

Within the frame of this study also, ring electrodes were positioned at the proximal and distal interphalangeal joints of the index finger for the median nerve to record points of SDL that were collected antidromically. The SDL was calculated by comparing the stimulating artifact to the peak of the sensory nerve action potential at a distance of 14 cm between the stimulator and the recording electrode.

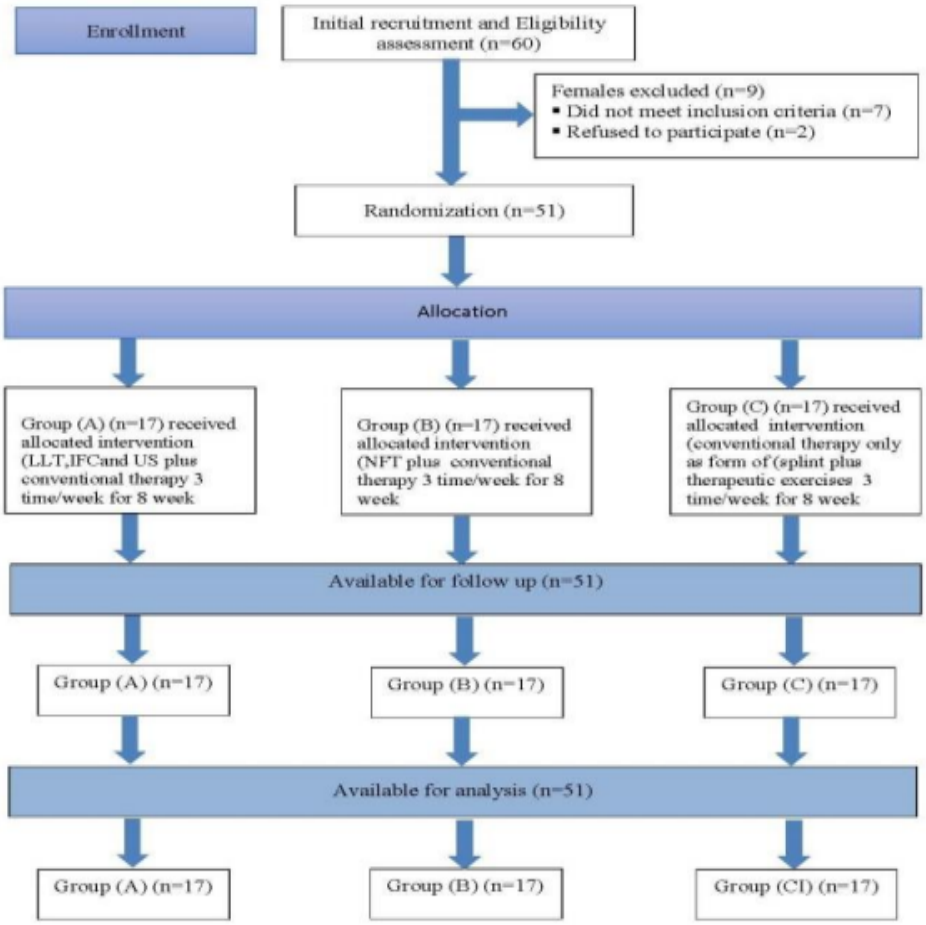

FIGURE 1: Consort flow diagram

Data and statistical analysis

The Statistical Package for Social Science (SPSS) version 25 for Windows was adopted for the statistical analysis. The Shapiro-Wilks normality test was initially utilized to check the data for normality assumptions. Also, the data were examined for kurtosis, considerable skewness, and extreme scores. The data were additionally examined for homogeneity of variance. As soon as it was determined that the data did not deviate from the assumptions of normality and homogeneity of variance, parametric data analysis was carried out. In order to compare the tested variables between the pre-test and post-test conditions in each of the three tested groups as well as between the pre-test and post-test conditions in each tested group, a 3x2 mixed-design MANOVA was carried out. The alpha level was initially set at 0.05.

RESULTS

As indicated by the one-way analysis of the Variance test, there was no marked disparity ($p > 0.05$) in the mean values of age, weight, height, and body mass index among groups (Table 1). The 3x2 mixed design of MANOVA statistical analysis showed that there was a noticeable interaction between the treatment group (F-value = 422.557, p-value = 0.0001*, Partial Eta square = 0.983), and there was a clear main effect of group (F-value = 4.493, p-value = 0.0001*, Partial Eta square=0.385). Still, there was no marked main effect of treatment (F-value = 5.212, p-value = 0.0001*, Partial Eta square = 0.421).

TABLE 1: Mean (SD) and one-way ANOVA for the participants' demographic data

	Group A	Group B	Group C	F- value	p-value
	$\overline{X}$ ±SD	$\overline{X}$ ±SD	$\overline{X}$ ±SD		
Age (years)	35.58 ± 4.65	35.52 ± 4.70	37.23 ± 5.01	0.693	0.505
Body mass (kg)	64.41 ± 7.33	63.17 ± 4.70	63.76 ± 3.41	0.222	0.802
Height (m)	1.68 ± 0.09	1.69 ± 0.08	1.68 ± 0.06	0.107	0.898
BMI (kg/m²)	22.58 ± 1.41	21.93 ± 1.54	22.71 ±1.31	1.451	0.244

$\overline{X}$: Mean, SD: Standard deviation, ANOVA; One-way analysis of variance, p -value: Probability value.

Based on the mean values of all outcome measures when comparing results pre-intervention and post-intervention in all groups, there was a marked reduction (p-value < 0.05) in VAS, FSS, SSS, SDL, and MDL and a remarkable increase in pinch grip (p-value < 0.05) in favor of the post-intervention compared to the pre-intervention. While among groups, There was an obvious decline. (p-value < 0.05) in post-intervention VAS, FSS, SSS, SDL, and MDL and a noticeable increase in pinch grip (p-value < 0.05). Between (group A versus group C) and (group B versus group C) in favor of groups (A) and (B) than group (C). While there was no marked disparity in the post-intervention mean values of all outcome measures between (groups A versus B) (p-value >0.05) (Table 2).

TABLE 2: Descriptive statistics for the outcome parameters assessed in the both measuring periods in each tested group.

Outcome measures		Group A (N=17)	Group B (N=17)	Group C (N=17)	Among groups (p- value)		
					G A Vs. B	G A Vs. C	G B Vs. C
VAS	Pre	7.47±0.87	7.29±0.91	7.76±0.90	0.999	0.998	0.401
	Post	3.47 ±0.94	3.41±0.79	5.29±0.98	0.999	0.0001*	0.0001*
Within group (p- value)		0.0001*	0.0001*	0.0001*			
Pinch grip	Pre	3.64±1.16	3.97±1.23	3.47±1.26	0.999	0.999	0.718
	Post	6.14 ±1.37	6.44±1.27	4.88±1.12	0.999	0.017*	0.002*
Within group (p- value)		0.0001*	0.0001*	0.0001*			
FSS	Pre	3.88±0.62	4.05±0.52	4.17±0.46	0.999	0.364	0.999
	Post	1.79 ±0.56	2.02±0.59	2.94±0.63	0.773	0.0001*	0.0001*
Within group (p- value)		0.0001*	0.0001*	0.0001*			
SSS	Pre	4.11±0.60	3.88±0.60	4.11±0.48	0.691	0.999	0.691
	Post	1.94 ±0.74	1.82±0.52	2.82±0.52	0.999	0.0001*	0.0001*
Within group (p- value)		0.0001*	0.0001*	0.0001*			
SDL	Pre	3.67±0.08	3.70±0.10	3.74±0.13	0.999	0.262	0.999
	Post	3.30±0.08	3.35±0.06	3.42±0.06	0.209	0.0001*	0.023*
Within group (p- value)		0.0001*	0.0001*	0.0001*			
MDL	Pre	4.22±0.09	4.23±0.09	4.25±0.08	0.999	0.814	0.999
	Post	3.77 ±0.10	3.80±0.11	3.93±0.07	0.999	0.0001*	0.002*
Within group (p- value)		0.0001*	0.0001*	0.0001*			

Data expressed by mean and standard deviation; VAS: Visual Analogue Scale; FSS: function status scale; SSS: symptom severity scale; SDL: sensory distal latency; MDL:motor distal latency; significance level put at $P \leq 0.05$.

DISCUSSION

CTS is a serious medical condition that could severely impair the ability to conduct daily tasks and lessen the hand's functional capability. Due to their heavy domestic duties, women are more likely to develop the syndrome than males are after the age of 30[5, 34]. The symptoms of CTS are quite varied. The symptoms are primarily brought on by mechanical trauma, repetitive force, and ischemic injury to the median nerve, which compresses the nerve within the C.T. In order to optimize the mechanical interface for the median nerve and reduce nerve irritability in order to improve neural function, people with CTS typically complain of pain and sensory abnormalities [35].

As there are several physiotherapeutic techniques for treating mild to moderate CTS and there is no consensus on the best effective method to manage CTS, the choice of treatment for CTS is still up for debate[3]. The clinical trials required to determine the effectiveness of various modalities in the treatment of CTS should be done; Currently, there are only a few studies available comparing outcomes between a novel treatment strategy and a combination of techniques [36]. The target of this study was to examine the effectiveness of the multimodal electrotherapy strategy and the median NFT on pain intensity level, pinch grip strength, FSS, SSS, SDL, and MDL in patients with chronic CTS. The current study looked at these variables.

The main results of the present academic work demonstrated that all treatment groups experienced a meaningful improvement in all variables (pain intensity level, pinch grip strength, FSS, SSS, SDL, and MDL) following treatment, with Group A (multimodal approach of electrotherapy with conventional physical therapy modalities in the form of a splint and therapeutic exercises) and Group B (NFT with conventional physical therapy modalities in the form of a splint and therapeutic exercises)showing no statistically significant difference. Even so, there was a big difference between them and Group C, which received traditional physical treatment methods like a splint and therapeutic exercises.

On another level, the findings of this work are in line with those of Bakhtiary et al. [37], who looked at the effects of various forms of combined physical therapy and came to the conclusion that therapeutic combinations like hot packs plus active ROM and stretching with spray as well as LLLT plus US as well as NFT are most effective for reducing ischemic pain by assisting in the delivery of oxygenated blood to the median nerve, reducing symptoms, removing adhesions, and enhancing excursion.

The outcomes are consistent with academic research was done by Talebi et al. [38], which found that NFT is an effective manual therapy technique for raising pain thresholds, boosting grip strength, reducing disability, and enhancing nerve conduction in people with chronic CTS. Moreover, Horng et al. [39] discovered that combining nerve gliding exercises with conventional therapy improved electrophysiological and clinical measures more effectively than conventional treatments alone in women with chronic CTS.

The results of this investigation supported those of Dincer et al. [40], who distinguished the effectiveness of LLLT plus US to splinting alone in the management of chronic CTS. They discovered that combination therapy was more effective than splinting alone in treating CTS cases, reducing VAS, FSS, SSS, and increasing pinch grip strength, and improving neurophysiological parameters.

This study supported Pattapong et al. [41], who compared the effects of MLS laser therapy with traditional rehabilitation treatments for mild to moderate CTS, including wrist splints and stretching exercises, to a control group that received only placebo laser therapy. Both groups showed improvement. Nonetheless, there was a statistically significant difference between the two groups, with the intervention group (MLS laser therapy) outperforming the control group in terms of improving the neurophysiological treatment parameters and pain alleviation in people with CTS.

The results of the current study contrast with those of Gobichandran et al.'s [42] comparison of the effects of US therapy versus NFT on pain and

function status in patients with mild to moderate CTS and their subsequent conclusion that the U.S. group demonstrated superior improvement to NFT on CTS treatment. However, our research showed that NFT treatment for CTS had a similar impact on the US group. The results of the current investigation do not agree with the conclusions that were previously reported. Due to the prior study's numerous flaws, which included The NFT has been repeated a total of 15 times. The treatment period for the prior finding was just 3 weeks long, but the treatment period in the present trial was 8 weeks, and the number of repetitions of NFT was 24. All of these could lead to different outcomes.

This study contradicts the findings of another one by Sim et al. [25] that compared the clinical outcome with splinting alone versus a combination of splinting, tendon gliding exercises, and US therapy for the treatment of CTS. While their study found similar results using the BCTQ between the orthosis and multimodal therapy groups, demonstrating that both orthosis and multimodal therapy led to significantly improved SSS and FSS, the combination of orthosis, nerve, and tendon gliding exercises.

Their interpretation of the results is based on the assessment of SSS and FSS using the BCTQ in the study that took place directly after the cases had removed the orthosis since it was desired to conduct the evaluation using the BCTQ after the case returned to her activities. In contrast to their study, which only did US therapy and tendon gliding once per week, this research study repeated US therapy and nerve gliding three times per week. These could all result in various results.

While Brininger et al. [43] and Ballestero et al. [44] stated that the effectiveness of the NFT in people with chronic CTS was restricted when comparing splinting and NFT, their findings did not line up with the current findings. All cases had comparable FSS and VAS scores, with no discernible variations between the two groups.

Since CTS symptoms can vary in intensity and because different age groups (18–80) were used to compare the effects, the results from a comparison between splinting and NFT took one month to treat CTS. However, in order to reach the best findings, this study was conducted over a two-month period and a more narrowly defined age range was taken into account.

In a nutshell, this study reflected the idea that there was no marked disparity between the multimodal approaches of electrotherapy and NFT on pain intensity level, pinch grip strength, FSS, SSS, SDL, and MDL in patients with chronic CTS when determining which was more effective in its results during treatment of chronic CTS. This was the first study to examine the effectiveness of multiple electrotherapy modalities and NFT in treating patients with chronic CTS. Thus, the current paper represents the first research on this topic. Hence, the outcomes of this study indicated that neither intervention differed from the other when adopted as a conservative treatment for patients with mild to moderate CTS.

CONCLUSIONS

Upon the outcomes of the current study, the multimodal approach of electrotherapy with conventional physical therapy in the form of a splint, stretching, and strengthening exercises, on the other hand, NFT with conventional physical therapy in the form of a splint and strengthening exercises that were both equally effective in treating people with chronic CTS,there was no significant difference between them. This improvement was reflected in the significant decline in VAS assessment for pain, improvements in pinch grip strength, the drop in SSS and FSS as a measure of functional restriction and symptom severity, and the reduction in SDL and MDL in groups A and B, all of which demonstrate noticeable improvements.

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