

# Pulsed Type Ultrasound Verses Diclofenac Phonophoresis in the Treatment of Carpal Tunnel Syndrome

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## ABSTRACT

**Background:** Definitive evidence suggesting the successful treatment of carpal tunnel syndrome (CTS), a widespread nerve entrapment. Ultrasound therapy (UST) and phonophoresis technique improve symptoms in CTS.

**Aims:** To compare the effectiveness of the treatment of CTS in the pulsed type ultrasound, and diclofenac phonophoresis to keep the patient's situation stable without getting worse, and treating patients with conservative approaches away from invasive procedures and local injection.

**Patients and Methods:** This randomized clinical trials RCT study including a total of 50 patients with CTS (6 males and 44 females) who were attending the Rheumatology and Rehabilitation Department in Al – Imammein Al- Kadhimaiein Medical City for four months' period (from October 2019 to January of 2020). Patients were subjected to clinical and electrophysiological study. Other data were collected by Boston Carpal Tunnel Syndrome Questionnaire (BCTQ) and socio-demographic questionnaire.

**Result:** When compared with baseline, the two groups revealed significant development in the BCTQ scores, with significant distinctions between the two groups. The enhancement of the phonophoresis group was greater than the ultrasound group. The results of enhancement in nerve conduction studies (NCS) findings at left and side hands between two groups were not a significant statistical association between the groups, with good improvement, while enhancement in the electrodiagnostic study between two groups shows that shorter latency (ms) of median motor distal latency and median sensory distal latency in both right and left side hands for two groups with no significant differences. Increase in median motor conduction velocity (m/s), and median sensory conduction velocity (m/s) in both hands for phonophoresis group, with significant differences between two groups in median motor conduction velocity (m/s) for right side hand and borderline differences in median motor conduction velocity (m/s) for left side hand.

**Conclusion:** While both phonophoresis and ultrasound therapy has been active in reducing symptoms of patients with mild and moderate CTS and in improving function and electrophysiological findings with significant differences in many parameters. Phonophoresis may be better than ultrasound therapy in the CTS treatment, although statistically, there's no significant difference observed between the two groups. An important point that even in severe cases, both techniques had been successful.

**Keywords:** Carpal tunnel syndrome, Diclofenac phonophoresis, Therapeutic ultrasound.

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## INTRODUCTION

CTS have been the most severe peripheral neuropathy. The consequence of median nerve compression in the wrist joint,<sup>18</sup> Bounded by transverse carpal ligament (TCL) and carpal bones. The main symptoms contain paresthesia, numbness, and pain in the median nerve distribution. Symptoms occasionally associated with objective changes in sensation and median-innervated hands structures strength.<sup>6</sup>

CTS is classified as affecting one in 10 people during their lifetime, and it is the most common syndrome of nerve compression.<sup>15</sup> It estimates about ninety percent of total syndromes of nerve compressing.<sup>9</sup> CTS are the highly prevalent entrapment neuropathy. With spread levels up to 9.2% in females and 6% in males.<sup>16</sup> Whereas in Iraqi populations, 26% of patients are between 15–30 years of age and 51% are between 31–45 years of age younger. The women who belong

to this age group are of age of reproduction and completion of families with the height of household responsibilities of our society. Most women 50 years of age and older will have fewer household responsibilities, and this explores.<sup>10</sup>

Lines of Treatment for CTS are based on surgical as well as conservative treatment. The surgical intervention is indicated when symptoms are so severe that they interfere with daily activities.<sup>7</sup> Conservative treatment is the first choice unless progress motor deficiencies, severe sensory deficiencies, or serious electrophysiological deviation.<sup>7</sup>

Conservative therapies which are most common include: Modify the daily activities, physical agents (Ultrasonography, laser therapy, paraffin bath, short wave diathermy), drugs (Non-steroidal anti-inflammatory drug, oral or intra carpal steroid injections), and a splint for hand and wrist.

**Surgical Intervention:** The release surgery for CTS should be done in patients with symptoms not responsive to conservative therapy. In patients with critical nerve entrapment, nerve conduction studies, motor weakness, and atrophy in thenar muscle are revealed. It's serious to remember this surgery can remain successful even if patients have normal nerve conduction studies.<sup>12,5</sup> The study's rationale is to find out the different effects of pulsed therapeutic US and phonophoresis techniques in CTS treatment. And the study is related to decreasing ADL activity of daily living for all patients, especially in the moderate stages. So it is important to treat them with the simplest approach to reduce their symptoms by providing an initial better concentration of drugs at the delivery site, preventing gastric irritation, and avoiding the liver's first-pass metabolism. Transcutaneous delivery avoids too the trauma, pain, and contamination risk associated with the injection.

The reasons which motivated me to select this subject were the lack of enough data about the phonophoresis technique in treating CTS.

Our aims are to compare the effectiveness of CTS treatment by the pulsed type ultrasound and Diclofenac phonophoresis to keep the patient's situation stable, without getting worse, and treating patients with conservative approaches away from invasive procedures and local injection.

## MATERIALS AND METHODS

**Study Design:** The study was a prospective, designed as a double-blinded analytic study, interventional, randomized clinical trials (RCT) comparing ultrasound versus Phonophoresis of Diclofenac in treating carpal tunnel syndrome (CTS).

**Study Setting:** This present study was accomplished at Rheumatology and rehabilitation department Al-Imammein Al-Kadhimaiein Medical City for four months' period (from October 2019 to January of 2020).

**Source and Study Population:** Initially, sixty patients with mild and/or moderate CTS had been included in this research. Fifty people were involved in the actual analysis containing forty-four (88%) females and six (12%) males. According to a validated CTS electrophysiological severity scale, mild CTS was defined as discontinuous symptoms without the absence

of sensations, thenar muscle atrophy or muscle weakness, and moderate CTS has been described as abnormal distal latency of the motor and slowing sensory conductivity.<sup>14</sup>

For the sample size calculation, Previous (RCT) studies performed in patients undergoing ultrasonic therapy and phonophoresis of Ketoprofen in the handling of CTS,<sup>20</sup> the sampling procedure was fifty patients with CTS, aged between (26–73) years were assigned randomly in two groups:

**Group (A):** forty-two hands of twenty-five patients (4 males and 21 females) aged between (30–73 years), inclusion criteria needed patients suffering from subjective CTS symptoms (i.e., paresthesia, presence of pain, numbness/tingling in the supplying of the median nerve) was subjected to pulsed therapeutic ultrasound (using normal gel), with a duty cycle of (20%), the intensity of (1.0–2.0 W/cm<sup>2</sup>), and frequency of (1 MHz), for about (5–10) minutes with (8–12) session (about 2–3) sessions weekly for one month. We excluded patients with severe CTS, pregnancy, and patients with local injections in about 3 months.

**Group (B):** Thirty-six hands of twenty-five patients (2 males and 23 females) aged between (26–65 years) with clinical features of CTS, was subjected to phonophoresis (using pulsed therapeutic ultrasound with Diclofenac gel) with a duty cycle (20%), intensity (1.0–2.0 W/cm<sup>2</sup>), frequency (1 MHz), for (5–10) minutes with (8–12) sessions (about 2–3) sessions weekly for one month. Time and number of sessions depend on case severity (i.e., in mild case 5 minutes for 8 sessions, while in moderate case, the time of the session is 10 minutes for 12 times per month).

**Study Variables:** median sensory distal latency (MSDL), median motor distal latency (MMDL), median motor conduction velocity (MMCV), median sensory conduction velocity (MSCV), functional status scale, and symptoms severity scale.

## Data Collection Method and Instrument

**Questionnaire:** For data collection, the Boston Questionnaire of Carpal Tunnel Syndrome (BCTQ) was utilized; the questionnaire contains two parts:

**Part one:** Eleven items, including information about symptom severity scale such as the pain in hand or wrist at night, are there weakness, tingling sensation in the patient's hand, etc. This item was scored from 1 (mildest) point to 5 (most severe) points. For estimating pain in the hand and wrist, a point on a (10 cm) visual analog scale (VAS) was asked to be marked by patients, Start at 0 (no pain) to 10 (worst pain).<sup>11</sup>

**Part two:** Eight items including information about functional status scales such as gripping of a telephone handle, buttoning of clothes, holding a book while reading and writing, opening of jars, household chores, carrying of grocery basket, dressing, and bathing. These eight questions Start at 1 point [no difficulties with the activity of daily living (ADL)] to 5 points (could not doing the activity at all).

The score of the individual item is calculated as the *mean* of the responses—the worse symptom or function represented by, the higher score.<sup>8</sup>

In addition to the socio-demographic of the participant, who provided the basic information such as age, gender, weight, length, symptom duration, occupation, dominant hand, other associated disease and electromyography (EMG), and NCS finding. The participants were selected randomly to answer the questionnaire, and there is an explanation about each item in it.

#### Instrumentation:

**EMG Machine:** Sensorimotor NCSs for the median and ulnar nerve is performed for all participants, using (Micro med, B model 1715, 8 - channel electromyography, made in Italy) which is computerized EMG equipment. All tests were performed pre-physiotherapy sessions (at a baseline) and after six to eight weeks post-physiotherapy sessions.

**Therapeutic Ultrasound (TUS) Device:** TUS device (Matrix, made in India) was used for treating all studied subjects.

**Ethical Considerations:** Before collecting data, the researcher sought approval from the Department of Rheumatology and Rehabilitation in Al-Imamain Al-Kadhmain Medical City. Each participant also obtained written consent and was informed about the purpose of the study; all info regarding participants was kept confidential.

**Data Analysis and Procedure:** The data were processed using SPSS version 16.0.0, Microsoft Excel 2010, and Graph pad Prism version 7.04. The data of the current study were scrutinized in terms of being parametric or non-parametric using normality tests. Accordingly, the proper statistical tests were used. Student t-test and ANOVA test were used for parametric data, and the Mann-Whitney test was used for non-parametric data to measure the significance of the difference in means taking into account whether variables of analysis sharing different or equal variance. For qualitative nominal data, Pearson's chi-square test, with or without Yate's correction, Fisher Exact test, and McNemar test were used to

measure the significance of the hypothesis for the association. Also, Correlation coefficient tests or,  $r$ , among variables were used to assess the nature of correlation in terms of positive, negative, or indifference. The diagnostic performance of a test or the accuracy of a test to discriminate diseased cases from normal cases was evaluated using receiver operating characteristic (ROC) curve analysis.

#### RESULTS

**Clinical Data:** A total of 78 symptomatic hands of 50 (6 males and 44 females) patients with a median nerve entrapment or CTS were examined after having to complete one month of treatment. Participants aged from (26 to 73) years had mean age  $\pm$  standard deviation = (44.90  $\pm$  10.39) years. And their body mass index (BMI) ranged from (21.80 to 44.98) kg/m<sup>2</sup> had mean BMI  $\pm$  standard deviation = (30.75  $\pm$  5.01) kg/m<sup>2</sup>. The symptoms duration was extended from (1) month to (48) months with mean and standard deviation = (10.58  $\pm$  11.11) months. Symptoms score ranged from (1.27 to 4) mean = 2.73, while functional scores ranged from (1 to 3.37) mean = 1.96, respectively. Table 1 summarizes socio-demographic baseline data and clinical features of the population sample.

#### The Phonophoresis Group

This group has 25 participants with thirty-six hands, 23 (92%) females and 2 (8%) males, aged between (26–65 years). Most females are housewives 19 and 4 others in their occupation. The enhancement in electrophysiological study in left side hand revealed significant differences in functional score, MMDL/L (ms), MSDL/L (ms) at  $P = 0.04$ ,  $P = 0.016$ , and  $P = 0.042$  respectively, and borderline in MSCV/L (m/s) with  $P = 0.077$ . While the enhancement in electrophysiological study in right side hand shows significant differences in MMDL/R (ms), MSCV/R (m/s), at  $P = 0.006$ , and  $P = 0.015$ , respectively.

**Table 1:** Socio-demographic characteristics for all participants

Parameter	N	Minimum	Maximum	Mean	Standard Deviation
• Age (year)	50	26.00	73.00	44.9000	10.39869
• mass (kg)	50	63.00	130.00	82.1400	16.43293
• Height (cm)	50	150.00	180.00	1.6308E2	6.67875
• BMI	50	21.80	44.98	30.7590	5.01320
• Duration of symptoms (month)	50	1.00	48.00	10.5800	11.11552
• Symptoms score	50	1.27	4.00	2.7394	0.65690
• Functional score	50	1.00	3.37	1.9634	0.47627
• MMDL- right (ms)	43	2.50	6.00	4.0326	0.87143
• MSDL- right (ms)	43	2.30	6.00	3.4581	0.89555
• MMCV- right (m/s)	43	41.40	82.10	59.4116	8.10688
• MSCV- right (m/s)	43	22.60	56.50	39.1977	7.96123
• MMDL- left (ms)	43	2.40	6.00	3.8860	0.88602
• MSDL- left (ms)	43	2.40	6.00	3.4093	0.82254
• MMCV- left (m/s)	43	38.80	96.00	60.5767	10.08790
• MSCV- left (m/s)	43	26.90	68.70	40.5767	8.38112

MMDL= median motor distal latency in meter\*second, MSDL= median sensory distal latency in meter\*second, MMCV= median motor conduction velocity in meter/second, MSCV= median sensory conduction velocity in meter/second.

In the other hand, the NCS findings at right side hands of pre-and post-treatment, although the NCS finding at right side hands were shown to be non-significantly associated with pre-and post-treatment ( $p > 0.05$ ). An analysis showed improvement in post-treatment findings for NCS, which 2 hands in a normal degree, 9 hands in mild degree, 10 hands to a moderate degree, and no hands in a sever degree, as shown in Table 2. And NCS finding at left side hands of pre-and post-treatment ( $p > 0.05$ ) may not have a significant association. However, the study showed improvement in the finding of NCS after treatment, 4 hands in a normal degree, 6 hands in a mild degree, 5 hands to a moderate degree, and no hands in a severe degree, as seen in Table 3. The Mann Whitney Test showed highly significant differences (very good improvement); in post-treatment analysis, the mean dropped from (2.63 to 1.45) in the symptom score and from (2 to 1.37) in the functional score ( $p < 0.0001$ ).

**The Ultrasound Group**

This group comprises 25 participants with forty-two hands, 21 (84%) females and 4 (16%) males. Most females are housewives 16, and another 5, while the men are represented by two retired and two others. The enhancement in an electrophysiological study in the left side hand revealed significant differences in symptoms score and MMDL/L (ms), at ( $p = 0.04, p < 0.0001$ ) respectively. While the enhancement in electrophysiological study in right side hand shows significant differences in MSDL/R (ms) and MSCV/R (m/s), at ( $p = 0.004, p = 0.01$ ) respectively.

The NCS finding at right side hands of pre-and post-treatment showed no significant association with treatment ( $P > 0.05$ ), but analysis showed improvement in post-treatment findings for NCS, which 4 hands in normal degree, 14 hands in mild degree, 5 hands in moderate degree and no hands

**Table 2:** Pre and post-treatment nerve conduction study in phonophoresis group for right side hands

			<i>NCS finding in right side hand</i>				
			<i>Normal</i>	<i>Mild</i>	<i>Moderate</i>	<i>Severe</i>	<i>Total</i>
<i>P = 0.26</i>							
Pretreatment vs. post treatment	Pre-treatment	Count	0	9	10	2	21
		% within Pretreatment vs. post treatment	0%	42.9%	47.6%	9.5%	100.0%
		% within NCS finding (right)	0%	50.0%	50.0%	100.0%	50.0%
		% of Total	0%	21.4%	23.8%	4.8%	50.0%
	Post-treatment	Count	2	9	10	0	21
		% within Pretreatment vs. post treatment	9.5%	42.9%	47.6%	0%	100.0%
		% within NCS finding (right)	100.0%	50.0%	50.0%	0%	50.0%
		% of Total	4.8%	21.4%	23.8%	0%	50.0%
	Total	Count	2	18	20	2	42
		% within Pretreatment vs. post treatment	4.8%	42.9%	47.6%	100.0%	
		% within NCS finding (right)	100.0%	100.0%	100.0%	100.0%	
		% of Total	4.8%	42.9%	47.6%	4.8%	100.0%

**Table 3:** Pre and post-treatment nerve conduction study in phonophoresis group for left side hands

			<i>NCS finding in left side hand</i>				
			<i>Normal</i>	<i>Mild</i>	<i>Moderate</i>	<i>Severe</i>	<i>Total</i>
<i>P = 0.09</i>							
Pre vs. post	Pre-treatment	Count	0	8	5	2	15
		% within Pretreatment vs. post treatment	.0%	53.3%	33.3%	13.3%	100.0%
		% within NCS finding (left)	.0%	57.1%	50.0%	100.0%	50.0%
		% of Total	.0%	26.7%	16.7%	6.7%	50.0%
	Post-treatment	Count	4	6	5	0	15
		% within Pretreatment vs. post treatment	26.7%	40.0%	33.3%	.0%	100.0%
		% within NCS finding (left)	100.0%	42.9%	50.0%	.0%	50.0%
		% of Total	13.3%	20.0%	16.7%	.0%	50.0%
	Total	Count	4	14	10	2	30
		% within Pretreatment vs. post treatment	13.3%	46.7%	33.3%	100.0%	
		% within NCS finding (left)	100.0%	100.0%	100.0%	100.0%	
		% of Total	13.3%	46.7%	33.3%	6.7%	100.0%

in severe degree as shown in Table 4. And NCS finding at left side hands of pre- and post-treatment showed that were not significantly associated with treatment ( $P > 0.05$ ), but research showed improvement in post-treatment findings of NCS, and 3 hands in normal grade, 11 hands in mild grade, 5 hands in moderate grade, as shown in Table 5. The Mann Whitney Test revealed highly significant differences in post-treatment analysis, the median dropped from (2.63 to 1.45) in symptom score and from (1.87 to 1.25) in the functional score, ( $P < 0.0001$ ).

**Phonophoresis Group versus Ultrasound Group**

There was no statistically significant association in the enhancement of NCS finding at the left side hands between two groups ( $p > 0.05$ ) as demonstrated in Table 6, and there was no statistically significant association in NCS finding at the right side hands between two groups ( $p > 0.05$ ) as it showed in Table 7.

Table 8 showed the number of patients with enhancement compared with no enhancement in both phonophoresis and ultrasound groups. Significant differences at MMCV\_R (m/s) with p-value 0.01 and borderline differences at MMCV\_L (m/s), p-value=0.06. The Mann-Whitney test between the two groups revealed highly significant differences in symptom score (p-value = 0.001) and significant differences in the functional score (p-value = 0.02) between phonophoresis and ultrasound groups, as showed in Table 9.

**DISCUSSION**

The primary idea for this project was to estimate the usefulness of the phonophoresis (using ultrasound together with Diclofenac gel) methods when compared to ultrasound treatment and conservative therapy for the patient away surgical operation or local injection with a mild or moderate degree of CTS. The finding suggests that both techniques had a beneficial therapeutic effect, with the best effect with

**Table 4:** Pre and post-treatment nerve conduction study in ultrasound group for right side hands

			<i>NCS finding in right side hand</i>				<i>Total</i>	
			<i>Normal</i>	<i>Mild</i>	<i>Moderate</i>	<i>Severe</i>		
<i>P = 0.094</i>								
<b>Pre. Vs. post.</b>	Pre-treatment	Count	0	17	4	2	23	
		% within Pretreatment vs. post treatment	.0%	73.9%	17.4%	8.7%	100.0%	
		% within NCS finding right	.0%	54.8%	44.4%	100.0%	50.0%	
		% of Total	.0%	37.0%	8.7%	4.3%	50.0%	
		Post-treatment	Count	4	14	5	0	23
			% within Pretreatment vs. post treatment	17.4%	60.9%	21.7%	.0%	100.0%
	% within NCS finding right		100.0%	45.2%	55.6%	.0%	50.0%	
	% of Total		8.7%	30.4%	10.9%	.0%	50.0%	
	Total		Count	4	31	9	2	46
			% within Pretreatment vs. post treatment	8.7%	67.4%	19.6%	4.3%	100.0%
		% within NCS finding right	100.0%	100.0%	100.0%	100.0%		
		% of Total	8.7%	67.4%	19.6%	4.3%	100.0%	

**Table 5:** pre and post-treatment nerve conduction study in ultrasound group for left side hands

			<i>NCS finding in left side hand</i>				
			<i>Normal</i>	<i>Mild</i>	<i>Moderate</i>	<i>Total</i>	
<i>P=0.12</i>							
<b>Pretreatment Vs. Post treatment</b>	Pre-treatment	Count	0	10	9	19	
		% within Pretreatment vs. post treatment	.0%	52.6%	47.4%	100.0%	
		% within NCS finding (left)	.0%	47.6%	64.3%	50.0%	
		% of Total	.0%	26.3%	23.7%	50.0%	
		Post-treatment	Count	3	11	5	19
			% within Pretreatment vs. post treatment	15.8%	57.9%	26.3%	100.0%
	% within NCS finding (left)		100.0%	52.4%	35.7%	50.0%	
	% of Total		7.9%	28.9%	13.2%	50.0%	
	Total		Count	3	21	14	38
			% within Pretreatment vs. post treatment	7.9%	55.3%	36.8%	100.0%
		% within NCS finding (left)	100.0%	100.0%	100.0%		
		% of Total	7.9%	55.3%	36.8%	100.0%	

**Table 6:** Phonophoresis versus Ultrasound and the Enhancement in nerve conduction study findings at left side hand by Crosstab Test

			<i>Enhancement in NCS findings at left side hand (L)</i>		
			<i>No enhancement</i>	<i>Enhancement</i>	<i>Total</i>
<i>P = 0.35</i>					
Phonophoresis vs. ultrasound	Phonophoresis	Count	4	11	15
		% within Phonophoresis vs. ultrasound	26.7%	73.3%	100.0%
		% within Enhancement in NCS findings (L)	33.3%	50.0%	44.1%
		% of Total	11.8%	32.4%	44.1%
	Ultrasound	Count	8	11	19
		% within Phonophoresis vs. ultrasound	42.1%	57.9%	100.0%
		% within Enhancement in NCS findings (L)	66.7%	50.0%	55.9%
		% of Total	23.5%	32.4%	55.9%
	Total	Count	12	22	34
% within Phonophoresis vs. ultrasound		35.3%	64.7%	100.0%	
% within Enhancement in NCS findings (L)		100.0%	100.0%	100.0%	
% of Total		35.3%	64.7%	100.0%	

**Table 7:** Phonophoresis versus ultrasound and the enhancement in nerve conduction study findings at right side hand (R) by Crosstab test

			<i>Enhancement in NCS findings at right side hand (R)</i>		
			<i>No enhancement</i>	<i>Enhancement</i>	<i>Total %</i>
<i>P=0.78</i>					
Phonophoresis vs. ultrasound	Phonophoresis	Count	10	11	21
		% within Phonophoresis vs. ultrasound	47.6%	52.4%	100.0%
		% within Enhancement in NCS findings (R)	50.0%	45.8%	47.7%
		% of Total	22.7%	25.0%	47.7%
	Ultrasound	Count	10	13	23
		% within Phonophoresis vs. ultrasound	43.5%	56.5%	100.0%
		% within Enhancement in NCS findings (R)	50.0%	54.2%	52.3%
		% of Total	22.7%	29.5%	52.3%
	Total	Count	20	24	44
% within Phonophoresis vs. ultrasound		45.5%	54.5%	100.0%	
% within Enhancement in NCS findings (R)		100.0%	100.0%	100.0%	
% of Total		45.5%	54.5%	100.0%	

the phonophoresis technique. Improvement appeared in both objective and subjective perceptions. Diclofenac sodium topical gel is a drug of non-steroidal anti-inflammatory (NSAID) used primarily for topical purposes, it indicated the relief of osteoarthritis pain in joints responsive to topical dealing, as for the knee and the hands.

This study agreement with a study in 2011 on seventy-six median nerves, with a clinical and electrophysiological indication of mild or moderate CTS, subjects in this study received US therapy in pulsed mode (1:4) and frequency of (1 MHz), and (1 W/cm<sup>2</sup>) intensity, for 15 minutes duration, the follow-up after eight weeks. This paper aimed to compare

the effectiveness of ketoprofen phonophoresis (PH) and ultrasound (US) and in treating CTS. They found ketoprofen pH effective for pain reduction as adjuvant therapy on splinting. It is documented that the two US mechanical and thermal properties can play a vibrating role, high-speed cells and alter the resting potential of the cell membrane by cavitation to enhance ketoprofen diffusion.<sup>20</sup>

At the beginning of the study, the number of participants was 60, but the cause of the spread of the Coronavirus epidemic led to the non-participation of some patients to complete the nerve examination. Finally, this study includes 78 symptomatic hands of 50 (6 males and 44 females) patients who suffer from

**Table 8:** Comparison of sensory and motor parameters between phonophoresis and ultrasound groups

<i>Parameters</i>		<i>N</i>	<i>Mean</i>	<i>Standard Deviation</i>	<i>p-value</i>
Enhancement in MMDL_R (ms)	Phonophoresis	20	0.4900	0.56373	0.86
	Ultrasound	23	0.4652	0.34851	
Enhancement in MSDL_R (ms)	Phonophoresis	20	0.4200	0.70904	0.28
	Ultrasound	23	0.2348	0.38330	
Enhancement in MMCV_R (m/s)	Phonophoresis	20	2.0050	6.65112	0.01 (significant)
	Ultrasound	23	-2.2565	7.06134	
Enhancement in MSCV_R (m/s)	Phonophoresis	20	3.4150	5.80610	0.8
	Ultrasound	23	3.0043	4.78107	
Enhancement in MMDL_L (ms)	Phonophoresis	24	0.3958	0.44083	0.6
	Ultrasound	19	0.3263	0.41075	
Enhancement in MSDL_L (ms)	Phonophoresis	24	0.3750	0.51857	0.15
	Ultrasound	19	0.1684	0.38159	
Enhancement in MMCV_L (m/s)	Phonophoresis	24	1.5417	8.72687	0.06 (borderline)
	Ultrasound	19	-1.2579	7.42827	
Enhancement in MSCV_L (m/s)	Phonophoresis	24	3.3958	3.69259	0.24
	Ultrasound	19	1.2474	7.94973	

**Table 9:** Illustration the Mann Whitney Test values between two groups

<i>Parameters</i>		<i>N</i>	<i>Median</i>	<i>p-value</i>
Symptoms score	Phonophoresis	25	1.21	0.001
	Ultrasound	25	1.05	
	Total	50		
Functional score	Phonophoresis	25	0.63	0.02
	Ultrasound	25	0.6	
	Total	50		

CTS, split into two equivalent groups. The phonophoresis group has 25 participants with thirty-six hands, 23 females and 2 males, aged between 26 to 65 years), most females are housewives 19 and 4 others in their occupation, and Ultrasound group which comprises 25 participants, 21 females, and 4 males, most females are housewives 16, and another 5. While the men are represented by 2 retired and 2 others. In addition, CTS also involves hand-intensive activities such as housework and typing that can lead to increased occurrence among females.<sup>19</sup> This is compatible with my study, in which either housewives or administrative staff participated.

**In Phonophoresis Group:** Enhancement in an electrophysiological study in the left and right side hands shows significant differences in the functional score, MMDL/L (ms), MSDL/L (ms), borderline in MSCV/L (m/s), MMDL/R (ms) and MSCV/R (m/s). Another finding in this study was that NCS finding at left side hands of pre and post-treatment is not significant (although the study showed improvement in the finding after treatment), where 8 hands in mild degree, 5 hands to a moderate degree, and 2 hands in severe degree. And post sessions improved to become 4 hands in normal degree, 6 hands in a mild degree, 5 hands in a moderate degree, and no hands in severe degree. (It is the challenge of conducting sessions even in severe degrees and monitoring its results). NCS findings at the right side hands of pre-and

post-treatment show to be non-significantly associated, but improvement occurs in findings post-treatment, which 9 hands in mild degree, 10 hands in moderate grade, and two hands in a severe degree. And post sessions improved to become 2 hands in a normal degree, 9 hands in mild degree, 10 hands in a moderate degree and no hands in severe degree. Highly significant differences (very good improvement) in the Mann Whitney test for the Phonophoresis group in post-treatment analysis, the mean dropped from (2.63 to 1.45) in the symptom score and from (2 to 1.37) in the functional score.

Studies suggest that ultrasonic drug delivery is enhanced by the pressure exerted on the drug to push it into the skin. However, since the US exerts just a small amount of force, ultrasound is now thought to increase the penetration of transdermal drugs by improving the permeability of the stratum corneum by cavitation,<sup>13</sup> and it can enhance drug penetration even when applying before the drug is put on the skin.<sup>3</sup>

My findings are close to those of the Soyupek et al. study, 2012. That suggests that corticosteroid phonophoresis is the most successful form of treatment CTS according to ultrasonographic findings and others.<sup>17</sup>

**While in Ultrasound Group:** Enhancement in an electrophysiological study in the left and right side hands shows significant differences in symptoms score, MMDL/L (ms), MSDL/R (ms) and MSCV/R (m/s). Another finding in this study

was that NCS finding at left side hands of pre and post-treatment is not significant (although the study showed improvement in the finding after treatment), with 10 hands in mild degree, 9 hands to a moderate degree. And post sessions improved to become 3 hands in a normal degree, 11 hands in a mild degree, and 5 hands to a moderate degree. NCS findings at right side hands of pre- and post-treatment show to be non-significantly associated, but analysis showed improvement in post-treatment findings for NCS, which 17 hands in mild degree, 4 hands in moderate grade and 2 hands in severe degree. And post sessions improved to become 4 hands in normal degree, 14 hands in mild degree, 5 hands in a moderate degree and no hands in severe degree. (*Also it is the challenge of conducting sessions even in severe degree and monitoring its results*). Highly significant differences (very good improvement) in the Mann Whitney Test for ultrasound group in post-treatment analysis, the median dropped from (2.63 to 1.45) in the symptom score and from (1.87 to 1.25) in the functional score.

These results of my study were agreement with a study in 2014; this study comprised (46) CTS patients were splits into three groups, the first group (15 patients) used (0 W/cm<sup>2</sup>) placebo ultrasound treatments; the second group (16 patients) used (1.0 W/cm<sup>2</sup>) continuous ultrasound treatment, and the third group (15 patients) used (1.0 W/cm<sup>2</sup>) pulsed ultrasound treatment. The results of this study indicate significant changes in various parameters in all groups.<sup>1</sup>

In **comparison between two groups**, enhancement in NCS findings at left side hand, results of no statistically significant association between two groups, but the greater improvement in the phonophoresis group. Briefly, there was an enhancement of about 32.4% in a total of 44.1% in the phonophoresis group and about 32.4% in a total of 55.9% in the ultrasound group. A study in 2005 reported differences that are statistically significant in the treatment of epicondylopathy, between phonophoresis and the US.<sup>4</sup> Another finding in this study is that both techniques' enhancement in findings for the right side hands is not significantly different (although it was higher in the ultrasound group still statistically not significant). Briefly, there was an enhancement of about 25.0% in a total of 47.7% in the phonophoresis group and about 29.5% in a total of 52.3% in the ultrasound group. A study in 2010 of 34 CTS patients were part of this study, and the results showed that ultrasound therapy and injection of corticosteroids with a splint were efficient in the clinical symptoms, and the CTS findings electrophysiologically. Ultrasound may thus be an alternative treatment to CTS, particularly in patients who do not accept injection or splinting.<sup>2</sup>

In the present study, comparison of results between phonophoresis and ultrasound group show that shorter latency (ms) of MMDL and MSDL in both right and left side hands for two groups with no significant differences, and increase in MMCV (m/s), and MSCV (m/s) in both hands for phonophoresis group, with significant differences between two groups in MMCV (m/s) for right side hand, and borderline differences in MMCV (m/s) for left side hand.

My results showed improvement in the Boston Questionnaire, part one and part two (symptoms score and functional score) in both groups, which means that not only were symptoms reduced in patients, but the use of their hands in daily activities increased. This enhancement in the phonophoresis group was greater than the ultrasound group, the median symptom score in the phonophoresis group was 1.21, and in the ultrasound group was 1.05, highly significant differences. The median of the functional score was (0.63) in phonophoresis group and (0.6) in the ultrasound group (significant differences).

The main limitation of the present study is the non-compliance of participants, especially women who work as housewives, with recommendations and instructions to reduce harm and obtain better results. Another limitation of our research is the short-term follow-up; the result of the treatment was only measured at 6–8 weeks of follow-up.

## CONCLUSIONS

While both phonophoresis and ultrasound, therapy has successfully reduced the symptoms of mild to moderate CTS patients and improved function and electrophysiological findings with significant differences in some parameters. Phonophoresis may be more efficient than an ultrasound cure when handling CTS. Although statistically there is no significant difference between the two groups is found. Another important point is, even in severe cases, both techniques had been successful.

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