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Original Investigation

Efficacy of Low Level Laser Therapy in The Conservative Treatment of Carpal Tunnel Syndrome

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Abstract

Introduction: The aim of the present study is to assess the effect of laser therapy on pain, quality of life, and muscle strength in patients with carpal tunnel syndrome (CTS).

Methods: A total of 60 patient files diagnosed with CTS with history, physical examination, and electromyography (EMG) were analyzed retrospectively. Thirty patients who had received splint, exercise, and laser therapy were considered as the treatment group, and 30 patients who had received splint and exercise and waiting for laser therapy were considered as the control group. Demographic properties (age, gender, body mass index, dominant hand, helded hand, and repeated hand movements), clinical symptoms and physical examination results (Tinel's sign and Phalen's maneuver), EMG results, pain severity, quality of life, symptom and function severity scores, and muscle strength (triple and rough grip) were recorded from the patient's files. We evaluated pain with visual analog scale (VAS), quality of life with Health Assessment Questionnaire (HAQ), function with Boston Carpal Tunnel Scale, and muscle strength with pinch meter and dynamometer. Evaluations were made before treatment and at 2 and 4 weeks.

Results: There was no statistically significant difference between the groups in all parameters before the treatment. At second and third evaluations, statistically significant progress was determined in VAS, HAQ, and Boston symptom and function score in the control group. In the treatment group, statistically significant improvement was determined in pinch meter and dynamometer measures and all other parameters. Furthermore, all parameters, except for Boston function scores, were improved in the control group. There was no significant difference on physical examination results between the groups and between themselves.

Conclusion: As a result, we concluded that the combination of splint, exercise, and laser therapy was effective in the conservative treatment of CTS. With the addition of laser therapy to splint and exercise, the treatment results become more successful. Therefore, we hypothesized that laser therapy can be used more in the conservative treatment of CTS.

Keywords: Carpal tunnel syndrome, conservative treatment, laser

Introduction

Carpal tunnel syndrome (CTS) is the most frequently encountered entrapment neuropathy that results from compression of the median nerve as it passes through the carpal tunnel. It is the most common type of median nerve lesions (1-3).

The most common CTS is idiopathic CTS without any etiological cause. Secondary causes of CTS include factors such as rheumatoid arthritis, osteoarthritis, gout, dialysis-associated amyloidosis, distal radius fractures, space-occupying lesions, connective tissue diseases, diabetes, endocrinopathies such as hypothyroidism and mucopolysaccharidosis, anatomic variations, and infections (2, 3).

The diagnosis of CTS is easily established with anamnesis, clinical symptoms, and physical examination. Imaging and electrodiagnostic studies help to confirm the diagnosis (4).

The choices used in the conservative treatment of CTS include the use of resting splint, nerve and tendon gliding exercises, steroid injections, non-steroidal anti-inflammatory drugs, diuretics, vitamin B6, and physical treatment agents. Moreover, approaches for reducing mechanical compression, such as activity modification and changing work, are a part of conservative treatment. Contrast bath, ultrasound (US), transcutaneous electrical nerve stimulation, and low-level laser therapy are included among physical treatment modalities (5). There are a few studies evaluating the effectiveness of laser therapy in the treatment of CTS, and these studies have been conducted on an insufficient number of patients. There is no consensus on optimal dose and duration of laser therapy.

The aim of this study is to investigate the effectiveness of low-level laser therapy in pain, daily life, functional state, and muscle strength in the treatment of CTS.

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Methods

This study was conducted by retrospectively evaluating patient files to investigate the effectiveness of laser therapy in the treatment of CTS. The files of patients who applied to the outpatient clinic of physical therapy due to the complaints of pain and numbness in their hands and received laser therapy for the diagnosis of CTS or were waiting to receive treatment for CTS were examined.

Demographic data (age, gender, height, weight, education, repeating hand movements, affected hand, and dominant hand) and laboratory parameters (complete blood count, erythrocyte sedimentation rate, and C-reactive protein) of patients who were diagnosed with mild or moderate CTS after anamnesis, a physical examination and electrodiagnostic examinations were recorded.

The files of 60 patients were divided into two groups, each including 30 patients who were given treatment for the diagnosis of CTS and those who were waiting for treatment of the same diagnosis. The patients who received laser therapy in addition to splinting and exercising treatment constituted the treatment group (30 patients), and those who received splinting and exercising treatment but were waiting for laser therapy constituted the control group (30 patients).

Laser therapy was applied on the affected wrist in a total of 10 sessions given for 5 working days a week, except weekends, by using a LED gallium aluminum arsenide (GaAlAs) 1.6 W 808 nm wavelength diode laser device at 3 joule/cm^2, pulse 3500 Hz. It was administered through the method of complete contact with the CTS region at right angle.

The data consisted of findings including patients' sociodemographic features, dominant hands, affected hands, the presence of comorbidities, repeating hand movements, triple grip strength by pinchmeter, rough grip strength by dynamometer, and examination results.

While evaluating the symptoms and findings of the patients, the data obtained from the visual analog scale (VAS) for hand-wrist pain at resting and activity, the Health Assessment Questionnaire (HAQ) for investigating daily life activities, and the patient-based Boston Carpal Tunnel Syndrome Questionnaire designed as specific to CTS for investigating functions and severity of symptoms were examined (6, 7).

The data that were evaluated in the assessment of the patients were file records before treatment and in the 2nd week and the 1st month after treatment for the group receiving laser therapy. They were routine file records on the day of examination in the outpatient clinic and from the 2nd week and 1st month of waiting time for treatment. Data recorded on these days were compared in terms of effectiveness.

Pain

Hand-wrist pain was separately evaluated as resting and activity pain. The assessment was performed with VAS. A 10 cm line was drawn, and this line was numerated at 1 cm intervals. It was explained that 0 shows no pain, and 10 shows the most severe pain. The patient was asked to rate the pain with the most appropriate number on the scale (8).

HAQ Scoring

It is used for the assessment of general health state. It is a questionnaire having 8 areas in the disability index, and each includes 2-3 questions (a total of 20 questions) scored between 0 and 3 (6).

Provocation Tests

Phalen's test

This test is performed by asking patient to hold both hands with complete flexion of the wrists (at 90 degree) and wait for 60 seconds in this position. The development of paresthesia in the sensory distribution area of the median nerve within this period is accepted as positive (9-11).

Tinel's test

It is performed by tapping with a reflex hammer over the area of the carpal tunnel on the palmar aspect of the wrist. The presence of paresthesia in the sensory distribution of the median nerve on the hand is accepted as positive (10, 11).

Motor Evaluation

Grip strength was measured by a Jamar dynamometer (12).
Triple fingertip grip strength was evaluated with a pinchmeter (13).

Electrophysiological Evaluation

As an electrodiagnostic evaluation, motor and sensory nerve conduction tests were performed. The cases were graded as mild, moderate, and severe according to the electromyography results.

The Boston Carpal Tunnel Syndrome Questionnaire

This questionnaire, developed by Levine et al. in 1993, is completed by the patient herself/himself, and it consists of two parts: the symptom severity scale and functional state scale (7, 14).

In our study, illiterate patients were asked questions by the evaluator.

Statistical Analysis

Statistical analysis was performed by using the SPSS (Statistical Package for Social Sciences) version 15.0 (SPSS Inc.; Chicago, IL, USA) for Windows software. The comparisons of numerical variables between two independent groups were performed by the Student's t-test for normally distributed variables and by the Mann-Whitney U test for non-normally distributed variables. Dependent group comparisons were performed with the Friedman test. The analyses of subgroups were carried out through the Wilcoxon test and interpreted with the Bonferroni correction. Independent ratios of categorical variables between the groups were analyzed with the chi-squared test, and dependent ratios were analyzed with the McNemar test. The alpha significance level was accepted to be $p<0.05$.

Informed consent was obtained from the patients before the treatment on the examination in the outpatient clinic. Moreover, ethical approval for the study was obtained from the ethics committee for clinical research of our hospital.

Results

The study was conducted on a treatment group including 30 patients (26 female and 4 male) whose mean age was 45.90±7.97 years and a control group including 30 individuals (29 female and

1 male) whose mean age was 46.93±10.34 years. No statistically significant difference was found between the treatment and control groups in terms of the mean age, sex ratios, and educational status (p=0.666, p=0.353, p=0.209, respectively). The rate of repeating hand movements was 46.7% in both groups. There was no statistically significant difference in the rates of dominant hands and affected hands (p=0.353). No statistically significant difference was detected in the results of EMG (p=0.598). There was not any statistically significant difference between the groups with regard to the mean body mass index values (p=0.895) (Table 1).

No statistically significant difference was found between the groups in terms of the mean baseline values of resting/activity VAS, HAQ, Boston Symptom Score, Boston Function Score, pinchmeter, and dynamometer (p=0,101, p=0,117, p=0,113, p=0,105, p=0,068, p=0,974, p=0,598, respectively) (Table 2).

At the 2nd and 4th week examinations in the follow-up period, the values of VAS, HAQ, Boston Symptom Score, and Boston Function Score were significantly higher in the control group than in the treatment group (Table 3).

On the other hand, in the 2nd and 4th week examinations in the follow-up period, the values of pinchmeter and dynamometer were significantly higher in the treatment group than in the control group (Table 2).

When the treatment and control groups were evaluated within themselves, a statistically significant variation was observed in all parameters except the Boston Function Score in the control group and in all parameters in the treatment group (Table 2).

No statistically significant difference was detected between the groups and within the groups in terms of Tinel's and Phalen's test rates (Table 2).

Discussion

The diagnosis of CTS is established through an anamnesis and clinical examination. Imaging techniques and electrodiagnostic evaluation help to confirm the diagnosis and to make the differentiation of mild, moderate, and severe levels. In our study, which did not include severe CTS patients, 60% of patients in the treatment and control groups had mild CTS and 40% had moderate CTS. There was no significant difference between the treatment and control groups in terms of the CTS level.

At the beginning of the CTS treatment, hand-wrist resting splints, activity modifications, non-steroid anti-inflammatory drugs, nerve and tendon gliding exercises, physical treatment modalities such as laser and US, and conservative therapies such as steroid injections, are recommended. However, surgical treatment is recommended in the presence of severe CTS characterized by muscular atrophy and significant sensory loss and in cases for which conservative treatment does not work (15).

In the treatment of CTS, the use of hand-wrist resting splint is among the most common conservative treatment methods (16). In a review of Piazzini et al. (5) evaluating 33 randomized controlled studies, it was demonstrated that splinting was an effective treatment method for CTS, and it was more effective particularly when it was used for a whole day (5). In our study, the patients in both groups were given a splint holding their wrists in neutral position, and they were recommended to use it continuously for 2 weeks and then only at nights for the following 2 weeks.

While tendon and nerve gliding exercises are applied after surgery, they are also used in the conservative treatment of CTS. During exercises, the point of the median nerve affected by the highest pressure can vary. Due to this effect, venous return from the median nerve increases, and the pressure in the perineurium decreases.

Table 1. Analysis of demographic features

		Treatment	Control	p
Age		45.90±7.97	46.93±10.34	0.666
Gender	Female	26 (86.7)	29 (96.7)	0.353
	Male	4 (13.3)	1 (3.3)	
Education	Illiterate	0 (0.0)	1 (3.3)	0.209
	Primary school	17 (56.7)	22 (73.3)	
	Secondary school	3 (10.0)	4 (13.3)	
	High school	5 (16.7)	2 (6.7)	
	Higher education	5 (16.7)	1 (3.3)	
Repeating hand movements		14 (46.7)	14 (46.7)	1.000
Dominant hand	Right	29 (96.7)	26 (89.7)	0.353
	Left	1 (3.3)	3 (10.3)	
Affected hand	Right	23 (76.7)	18 (60.0)	0.165
	Left	7 (23.3)	12 (40.0)	
EMG	Mild	19 (63.3)	17 (56.7)	0.598
	Moderate	11 (36.7)	13 (43.3)	
BMI		29.68±4.52	29.52±5.05	0.895

EMG: electromyography; BMI: body mass index

Table 2. Comparison of the VAS, Tinel, Phalen, HAQ, Boston CTS Questionnaire, pinchmeter, and dynamometer values

		Treatment	Control	p
VAS resting	Baseline	7.00±2.03	7.90±1.77	0.101
	2nd week	2.93±2.53	5.37±2.54	<0.001*
	4th week	2.13±1.80	4.90±3.01	<0.001*
		<0.001*	<0.001*	
VAS activity	Baseline	6.90±1.86	7.63±1.75	0.117
	2nd week	3.20±2.35	5.60±2.85	0.001*
	4th week	2.33±1.75	4.70±3.10	0.003
		<0.001*	<0.001*	
Tinel	Baseline	26 (86.7)	28 (93.3)	0.671
	4th week	24 (80.0)	28 (93.3)	0.254
		0.500	1.000	
Phalen	Baseline	27 (90.0)	28 (93.3)	1.000
	4th week	25 (83.3)	28 (93.3)	0.424
		0.500	1.000	
HAQ	Baseline	14.40±10.00	19.03±12.22	0.113
	2nd week	7.30±7.50	16.07±11.66	0.006
	4th week	7.50±8.30	14.90±13.30	0.010
		<0.001*	0.017	
Boston Symptom Score	Baseline	3.06±0.72	3.39±0.83	0.105
	2nd week	1.90±0.66	2.87±1.03	<0.001*
	4th week	1.96±0.86	2.81±1.09	0.003
		<0.001*	0.001*	
Boston Function Score	Baseline	2.39±0.69	2.84±1.12	0.068
	2nd week	1.75±0.57	2.42±1.00	0.009
	4th week	1.76±0.70	2.57±1.13	0.004
		<0.001*	0.114	
Pinchmeter	Baseline	15.20±4.11	15.17±3.68	0.974
	2nd week	18.44±4.24	16.10±3.49	0.023
	4th week	19.40±4.47	16.70±3.14	0.015
		<0.001*	0.002	
Dynamometer	Baseline	39.17±18.87	36.20±17.50	0.598
	2nd week	52.00±19.50	40.27±16.01	0.014
	4th week	56.90±19.11	40.73±16.83	0.001*
		<0.001*	0.003	

VAS: visual analog scale; HAQ: health assessment questionnaire

In literature, there are a few studies evaluating the effectiveness of nerve and tendon gliding exercise in the treatment of CTS (17). In another study investigating the effectiveness of both splint types and tendon gliding exercises, no significant difference was reported between the groups doing exercises and not doing exercises in terms of CTS symptom severity and functional state (18). In our study, we wanted our patients to do tendon and nerve gliding exercises 5 times a day (each exercise to be repeated 5 times) in addition to splint and, in the follow-ups, we investigated whether they did them regularly or not. At the end of the treatment, we found that the patients benefited from the splint and exercises. In our study, while the values of VAS for activity and for resting in the 2nd and 4th weeks were significantly higher in the control group than in the treatment group, these values were observed to be decreased compared to the baseline values in both groups. That is to say, the VAS values gradually decreased with treatment both in the control group and in the treatment group, but the rate of this decrease was higher in the treatment group that was given laser therapy than in the control group. In a study conducted by Evcik et al. (19), one group (n: 41) was applied splinting and low-level laser therapy (7 joules/2 min), and the other group (n: 40) was applied splinting and placebo laser therapy for 10 sessions. It was reported that there was a significant improvement in night and daytime VAS values in both groups, but after the 12th week, this effect con-

Table 3. Comparison of the Tinel, Phalen, HAQ, Boston CTS Questionnaire, pinchmeter, and dynamometer values between the groups

		Treatment	Control
		p	p
VAS resting	Baseline-2nd week	<0.001*	<0.001*
	Baseline -4th week	<0.001*	<0.001*
VAS activity	Baseline -2nd week	<0.001*	<0.001*
	Baseline -4th week	<0.001*	<0.001*
HAQ	Baseline -2nd week	<0.001*	0.039
	Baseline -4th week	<0.001*	0.037
Boston Symptom Score	Baseline -2nd week	<0.001*	0.003
	Baseline -4th week	<0.001*	0.001*
Boston Function Score	Baseline -2nd week	<0.001*	-
	Baseline -4th week	<0.001*	-
Pinchmeter	Baseline -2nd week	<0.001*	0.013
	Baseline -4th week	<0.001*	0.002
Dynamometer	Baseline-2nd week	<0.001*	0.006
	Baseline -4th week	<0.001*	0.016

HAQ: health assessment questionnaire

tinued only in the group receiving laser therapy, and no significant difference was found between two groups when they were compared. In another study, patients diagnosed with CTS were put into three groups. One group was applied only splinting, the second group was applied splinting and ultrasound, and the third group was applied splinting and laser therapy. Then, the values of VAS were evaluated in the 1st and 3rd months after treatment, and a significant decrease was observed in all three groups, but the highest decrease was reported in the group receiving laser therapy (20). Moreover, in various studies, it was specified that laser had analgesic and anti-inflammatory effect, and this effect was associated with selective nociceptive inhibition in the peripheral nerves, increased the adenosine triphosphate production, increased cellular circulation, and endogenous opioid synthesis (21, 22). On the other hand, it is known that the splint treatment provides immobilization and causes analgesia.

Two provocative tests used in the diagnosis of CTS and known to be the best are Phalen's and Tinel's tests. Different results have been reported for the sensitivity and specificity of these tests in the literature. The sensitivity and specificity of the Tinel's test for CTS are 38-100% and 55-100%, respectively. Reported sensitivity of the Phalen's test is 42%-85%, and specificity is 54-98% (23, 24). In our study, the sensitivity was found to be 90% for the Tinel's test and 91.6% for the Phalen's test. In two randomized controlled studies investigating the effectiveness of laser therapy in CTS, the Tinel's and Phalen's test results were reported to become more negative after laser treatment at a significant rate (25, 26). In another study performed by Lazovic et al. (27), while one group was given real laser therapy, the other group was given placebo laser, and it was found in the control examinations that the Tinel's positivity interestingly decreased in both groups. In our study, no significant difference was detected in the Phalen's and Tinel's tests positivity in the follow-ups after treatment in both groups. We think that there was no difference because of the short follow-up duration.

Another clinical follow-up parameter used in our study was the Boston CTS Questionnaire. This scale, developed for the establishment of standardization in the clinical follow-up of CTS and based on a scoring system, consists of two parts: the symptom severity scale and the functional state scale. In our study, a significant decrease was observed in the Boston Symptom Scores in the follow-ups of both the treatment group and control group. However, in terms of the Boston Function Score, while no statistically significant variation was found in the control group, there was a decrease in the treatment group. When two groups were compared with each other, the rate of decrease was significantly higher in the treatment group given splint, exercise, and laser therapy than in the control group given only splint and exercise.

In another study, the Boston CTS Questionnaire was used in the follow-up in the control group applied splinting and in the treatment group applied splinting and laser therapy. While improvement was reported both in the symptom score and in the function score in the treatment group, no significant improvement was observed in the function score of the control group (28).

The hand grip strength, which is evaluated by a dynamometer, and triple holding strength, which is evaluated by a pinchmeter, are accepted as objective criteria for the functional integrity of the upper extremity, and they can be used for the objective evaluation of the function loss in hands. In a study conducted by Szabo et al. (29) on 100 patients, they found predictive values of the finger and hand grip strengths and the values of sensitivity and specificity to be low, and they specified that these measurements did not provide any benefit in the differential diagnosis of CTS, but could be useful in the follow-up of patients.

In our study, in the 2nd and 4th evaluation week in the follow-up period, the pinchmeter (pinch) and dynamometer (grip) scores were significantly higher in the treatment group than in the control group. In the comparisons of the treatment and control groups within themselves, a statistically significant variation was observed in these parameters in both groups. In other words, we detected that both splinting and laser therapy were effective in the improvement of motor function; however, laser therapy was observed to be more effective than splinting. We think that this improvement in motor functions was associated with decreased pain in both groups, but additionally with regenerative and anti-inflammatory effect of laser in the group receiving laser therapy.

In our study, when the changes in the pinchmeter and dynamometer scores were compared, there was no statistically significant difference found. In a review investigating the effectiveness of laser therapy in CTS on studies published between 2002 and 2010, it was reported that laser therapy provided a significant improvement in pain, dynamometer measures, and nerve conduction assessments (30).

Conclusion

We found in our study that exercise, splint, and laser therapy were effective in pain, severity of symptoms, function, and motor strength in the conservative treatment of CTS. We observed that while exercise and splint treatment were effective, laser therapy increased this effectiveness. Therefore, we think that laser therapy can be used in the treatment of CTS in addition to conservative treatments such as splint

and exercise. On the other hand, there are a few studies conducted for determining an optimal dose, duration, and the session number of laser therapy that will be used in different pathological conditions. In some devices, there are automatic programs that can adjust the dose and time of therapy, and these programs are followed. For this issue, further studies on larger patient groups and with longer follow-up are needed to determine an optimal dose and therapy duration.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of İstanbul Training and Research Hospital (Decision no: 2013/357).

Informed Consent: Informed consent was obtained from the patients who participated in this study.

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