

# Study of Long Term Effects of Laser Therapy Versus Local Corticosteroid Injection in Patients with Carpal Tunnel Syndrome

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**Introduction:** Carpal Tunnel Syndrome (CTS) is the most common compressive neuropathy. Several surgical and nonsurgical treatments have been proposed for this syndrome, but there is no consensus regarding the prioritization of the suggested nonsurgical treatments. The goal of this study was to compare the long term effects of laser therapy versus local corticosteroid injection in the treatment of CTS.

**Materials and methods:** During this single-blind randomized clinical trial, 65 hands with mild or moderate CTS were divided randomly into two groups. One group received local corticosteroid injection (Hydrocortisone 50 mg) and the other received low level laser therapy (20J/cm<sup>2</sup> in 11 seconds/session for each of 5 points, 775nm, 10 sessions and 3sessions/week). Furthermore, wrist splints with extension degree of 0° (neutral position) were prescribed simultaneously for 6 weeks in each group. Pain severity and electrodiagnostic measurements were compared from before to 10 months after completing each treatment. Data were analyzed with SPSS 11.5 software and parametric tests.

**Results:** Generally, the mean age of patients was 43.9 years, duration of pain was 7.4 months, male to female ratio was 1:3, pain severity using Visual Analogue Scale (VAS) was 6.1 cm, and functional status measure was 15.5. The severity of the disease based on electrodiagnostic studies was 43.2% mild (41.2% in injection group and 45.2% in laser therapy group) and 56.8% moderate. The electrodiagnostic characteristics of the median nerve prior to treatment were included mean sensory peak latency of 4.3ms, mean sensory amplitude of 23.5µv, mean motor onset latency of 4.3ms and mean motor amplitude of 4.6mv. There was no meaningful difference between two groups regarding the demographic characteristics and electrodiagnostic measures (p>0.05). Ten months after treatments, the mean of pain severity was decreased 1.9cm in injection group and 1.7cm in laser therapy group, the mean of median sensory peak latencies was decreased 0.4ms in injection group and 0.25ms in laser therapy group and the mean of motor onset latencies was decreased 0.15ms in both groups, with no significant difference between the observed treatments variables (P>0.05). The severity of disease based on electrodiagnostic studies became 32.4% normal, 23.5% mild, 41.2% moderate and 2.9% severe in the injection group and 38.7% normal, 22.6% mild, 35.5% moderate and 3.2% severe in the laser therapy group. There was no meaningful difference between two groups regarding the changes in the pain severity, functional status and electrodiagnostic measures.

**Conclusion:** Low level laser therapy can be as effective as local injection in reducing pain and severity of disease (based on electrodiagnostic medicine classification) in patients with mild and moderate CTS even in long term (after 10 months).

**Keywords:** Carpal Tunnel Syndrome, Laser therapy, Corticosteroids, Electrodiagnosis

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## INTRODUCTION

Carpal Tunnel Syndrome (CTS) is the most common compressive neuropathy involving the peripheral nerves. This syndrome is produced by the compression of the median nerve at the wrist. According to different studies, the prevalence of this disease is about 2.7% based on the clinical and electrodiagnostic findings.<sup>(1)</sup> Based on some references, the life time prevalence of this disease is up to 10%.<sup>(2)</sup> Carpal Tunnel Syndrome not only can cause discomfort for the patient, but also can interfere with social and occupational activities as well as activities of daily living.<sup>(3)</sup> Therefore, assessment of preventive and therapeutic strategies in this field is becoming increasingly the matter of interest for physicians and therapists.

There are several treatments recommended for this disease, but there is no consensus on the prioritization of these options.<sup>(4)</sup> Currently, application of splint, local corticosteroid injection and surgical release of the involved nerve are considered the standard treatments for the CTS. Although it seems that the therapeutic effects of the nonsurgical (conservative) treatments are limited,<sup>(5)</sup> surgical treatment is not useful in all patients and is most considered in severe cases.<sup>(6)</sup> Furthermore, there is significant unwillingness among the patients for being treated surgically.

There are several nonsurgical treatments suggested for this disease including local corticosteroid injection, application of splint, mobilization techniques and exercise programs, ultrasound and recently low level laser therapy. Among these options, local corticosteroid injection has longer background and more acceptability<sup>(7-10)</sup> Recently, low level laser therapy has been proposed as a nonaggressive therapeutic option for the treatment of several musculoskeletal disorders including the CTS. It seems that the mechanism of action for laser therapy is not due to thermal effects, but it is considered that this therapeutic method exerts its analgesic and local anti-inflammatory effects through the stimulation of microcirculation, inhibition of pain enzymes and activation of endorphin enzymes.<sup>(15)</sup> While some studies have shown the effectiveness of low level laser therapy in improving the symptoms of the CTS<sup>(11,12)</sup>, other studies have not shown its effects on the electrodiagnostic measures.

In the study of Irvine et al (2004) among patients with CTS, despite meaningful improvement in outcome based on clinical and electrodiagnostic findings, results in two groups receiving laser therapy (with intensity of 6 J/cm<sup>2</sup> and wavelength of 860 nm three sessions weekly for five weeks) and placebo were not different significantly.<sup>(13)</sup> In a review article scripted in 2006 about the effects of low level laser in the treatment of the CTS, it is concluded that laser has a hopeful future as a conservative treatment for the mild and moderate CTS, and it is a cost-effective method comparing to other commonplace treatments.<sup>(16)</sup> Rezasoltani et al (2008) in a study of 50 hands with mild and moderate CTS concluded that low level laser therapy (with intensity of 20 J/cm<sup>2</sup> in 11 seconds/session for each of 5 points, wavelength of 775 nm and frequency of 6500 Hz) at least in short term (2 months) can be as effective as local corticosteroid injection in the treatment of CTS.<sup>(17)</sup> Considering that up-to-date no conclusive study has been conducted comparing the long term effects of low level laser therapy with other treatment options such as local corticosteroid injection, we compare the long term effects of the low level laser therapy with local corticosteroid injection in this study. For comparing these two treatment methods we used the nerve conduction characteristics of the median nerve in electrodiagnostic studies, which can say is the best objective method for proving any nerve conduction disorder of the median nerve at the wrist,<sup>(14)</sup> pain severity and functional status measurements before and after accomplishing the treatment.

Our goal in this study was to determine if any of these two therapeutic methods has priority over the other concerning long term pain relief and nerve conduction characteristic improvement.

## MATERIALS AND METHODS

In this single blind randomized clinical trial we included all the patients with mild and moderate CTS referred to physical medicine and rehabilitation clinic of Imam Reza, (501) hospital whose diagnoses were made based on clinical and electrodiagnostic studies.

Definitions of disease severity based on electrodiagnostic findings was as follow: In mild cases, only the sensory fibers were involved without

further involvement of the motor fibers in such condition that the sensory wave was not absent, which means the sensory peak latency  $\geq 3.6$  ms and the motor onset latency  $\leq 4.1$  ms; In moderate cases, there was simultaneous involvement of both sensory and motor fibers in such condition that neither of the sensory nor the motor waves were absent, which means the sensory peak latency  $\geq 3.6$  ms and the motor onset latency of  $> 4.1$  ms; In severe cases, there might be absent sensory or motor waves, motor wave decreased amplitude and denervation in electromyography (EMG).<sup>(14)</sup> Exclusion criteria included the severe cases, secondary neuropathies (due to diabetes mellitus, thyroid disorders, amyloidosis, wrist trauma, etc.), cervical radiculopathy, double crush syndrome, thoracic outlet syndrome, history of previous treatment with local corticosteroid injection or low level laser during the past 6 months and general contraindications for the application of laser. Additionally, patients who were referred to our clinic just for performing the electrodiagnostic studies were not included in this study. The sampling method was simple randomization. According to the lack of any previous similar study, sample size in this study was considered to be 60 hands.

We took comprehensive history and did precise physical examination in patients who referred to our clinic with clinical suspicion of CTS (hand hypoesthesia, paresthesia or pain particularly in the first three digits, nocturnal pain and paresthesia and grip weakness). If the severity of the disease was under mild or moderate category, when there was no exclusion criteria based on history, physical and electrodiagnostic findings, after describing the study to the patients and signing the written consent form approved by the ethic committee of the Army University of Medical Sciences, we randomly divided the subjects into laser group and local corticosteroid injection group. In injection group, 50 mg of hydrocortisone was injected with an insulin needle just medial to the Palmaris longus tendon into the carpal tunnel. Patients in the laser group received 10 sessions of low level laser with wavelength of 775 nm, frequency of 6500 Hz and intensity of 20 J/cm<sup>2</sup> applied for 11 seconds along the median nerve pathway in the carpal tunnel.<sup>(17)</sup> For both groups, wrist splint in neutral position was applied for 6 weeks in order to provide relative rest to the wrist. Ethically we

could not have control group with no treatment to compare effects of laser therapy and steroid injection with. Patients should not receive further treatments during the follow-up period. Pain severity and functional status assessments as well as nerve conduction studies were performed before and 10 months after accomplishing the treatment by a physician not informed about the treatment methods.

Pain severity was assessed using Visual Analogue Scale (VAS). The patient marked the relative severity of pain on a 10-cm scaled tape. The zero point represented no pain and the 10 point represented the maximal pain severity. We determined the pain severity by calculating the distance between the zero point and the marked point.

We used the orthodromic technique for assessment of the median nerve sensory nerve action potential (SNAP). The recorder electrode was applied over the third finger and the distance between the active and reference electrodes was 4 cm.<sup>(14)</sup> Stimulation was produced at the wrist 14 cm proximal to the active electrode. Device sensitivity and sweep speed were set on 20  $\mu$ v and 2 ms/div, respectively. For calculating latency, peak latency and amplitude, base-to-peak measure was applied. For the assessment of the median nerve compound motor action potential (CMAP), the recorder electrode was applied on the abductor pollicis brevis (APB) muscle in a way that the active electrode was set over the most prominent area of the muscle and the reference electrode was applied over the palmar surface of the first metacarpophalangeal joint. The supramaximal stimulation was produced 8 cm proximal to the reference electrode (embowed calculation along the median nerve pathway).<sup>(14)</sup> Device sensitivity and sweep speed were set on 1 mv and 2 ms/div, respectively. For calculating latency, onset latency and amplitude, base-to-peak measure was used.<sup>(14)</sup>

Data analysis was performed using SPSS 11.5 software. Quantitative variables were expressed in mean and standard deviation and qualitative variables were expressed in percent. For comparing the quantitative variables before and after the treatment the paired T-test was performed, while a student T-test was used for comparing the qualitative variables between both groups, and for comparing the ratios Chi square and Fisher exact tests were applied.

**RESULTS**

In this study, 65 hands were assessed physically and electrodiagnostically. The mean age of patients was 43.9 years, duration of pain was 7.4 months, male to female ratio was 1:3, pain severity based on Visual Analogue Scale (VAS) was 6.1 cm, and functional status measure was 15.5. The severity of the disease based on electrodiagnostic studies was 43.2% mild (41.2% in injection group and 45.2% in laser therapy group) and 56.8% moderate. There was no meaningful difference between two groups regarding the demographic characteristics and electrodiagnostic measures ( $p>0.05$ ) (Table 1). Pain severity before (VAS1) and 10 months after accomplishing the treatments (VAS2) and the comparison of two groups are summarized in table 2.

The median nerve distal sensory latency before (DSL1) and 10 months after accomplishing the treatments (DSL2) and comparison of two groups are summarized in table 3. The median nerve distal motor latency before (DML1) and 10 months after accomplishing the treatments (DML2) and comparison of two groups are summarized in table 4.

There was no meaningful difference between the sensory and motor amplitude changes in both groups. Comparing different severities of the disease based on the electrodiagnostic findings before (Severity 1) and 10 months after accomplishing the treatment (Severity2) are mentioned in table 5. Before the treatment, the severity of the disease in the injection group based on electrodiagnostic findings was mild in 41.2% and moderate in the others. Ten months after injection the severity of disease based on electrodiagnostic studies became normal in 32.4%, mild in 23.5%, moderate in 41.2% and severe in 2.9%. Before the treatment, the severity of the disease in the laser group based on electrodiagnostic findings was mild in 45.2%

**Table 2.** Pain severity before (VAS1) and 10 months after accomplishing the treatments (VAS2) accompanied by the comparison of two groups

Group	Variable		
	Pain1 (VAS1)	Pain2* (VAS2)	Pv†
Injection therapy	6.1 ± 1.1	4.4 ± 2.5	P>0.05
Laser therapy	6.1 ± 1.0	4 ± 2.8	P>0.05

\*between groups after the trial: P=0.447  
†within each group (before & after the trial)

**Table 3.** The median nerve distal sensory latency before (DSL1) and 10 months after accomplishing the treatments (DSL2) and comparison of two groups

Group	Variable		
	DSL1	DSL2*	Pv†
Injection therapy	4.28 ± 0.36	3.9 ± 0.5	0.05
Laser therapy	4.25 ± 0.43	4 ± 0.6	P>0.05

\*between groups after the trial: P=0.70  
†comparing within each group (before & after the trial)

**Table 4.** The median nerve distal motor latency before (DML1) and 10 months after accomplishing the treatments (DML2) and comparison of two groups

Group	Variable		
	DML1	DML2*	Pv†
Injection therapy	4.3 ± 0.6	4.2 ± 0.7	<0.05
Laser therapy	4.33 ± 0.65	4.17 ± 0.8	<0.05

\*between groups after the trial: P=0.083  
†within each group (before & after the trial)

**Table 5.** Comparison of the different severities of the disease based on the electrodiagnostic findings before (Severity1) and 10 months after accomplishing the treatment (Severity2)

Group	Variable					
	Severity1(%)			Severity2(%)		
	Mild	Mod.	Normal	Mild	Mod.	Severe
Injection therapy	41.2	58.8	32.4	23.5	41.2	2.9
Laser therapy	45.2	54.8	38.7	22.6	35.5	3.2
Total	43.1	56.9	35.4	23.1	38.5	3.1

\*Chi Square test for comparing between groups after the trial: P>0.05

and moderate in the others. Ten months after the laser therapy the severity of disease based on

**Table 1.** Demographic characteristics and electrodiagnostic measures at the beginning of the study and comparison of two groups

Treatment	Variable					
	Age*	Female† /Total	Side ratio Rt/Total†	Pain* (VAS)	Pain duration*	Severity† (Mild/Total)
Injection	44.1 ± 9.5	82.4	61.8	6.1 ± 1.1	7.5 ± 4.8	41.2%
laser	43.7 ± 11.5	67.7	54.8	6.1 ± 1.0	7.2 ± 4.9	45.2%
Total	47.4 ± 10.0	5.3	1.4	5.9 ± 1.0	8.4 ± 5.4	43.2%

\*Mann-Whitney test: P>0.05  
†Fishers Exact test: P>0.05

**Table 6.** The changes in the grading of the disease based on electrodiagnostic findings before and after accomplishing the treatments

Treatment Group	Severity Changes		
	No change	Recoverd	Deteriorated
Injection	14 41.2%	*16 47.1%	4 11.8%
Laser	8 25.8%	*16 51.6%	7 22.6%
Total	22 33.8%	32 49.2%	11 16.9%
	33.8%	49.2%	16.9%

\*Chi Square test for comparing between groups after the trial: P>0.05

electrodiagnostic studies became normal in 38.7%, mild in 22.6%, moderate in 35.5% and severe in 3.2%. Table 6 demonstrates the changes in the grading of the disease based on electrodiagnostic findings before and after accomplishing the treatments.

## DISCUSSION AND CONCLUSION

In the injection and the laser therapy groups, pain severity as well as sensory and motor distal latency variables were improved in ten months after accomplishing the treatments, but these improvements were not statistically meaningful. There was no improvement in the sensory and motor amplitude variables. Furthermore, there was no significant difference between two groups comparing pain severity, functional measures and electrodiagnostic variables. In the study of Reza Soltani et al (2008), improvement in pain severity, distal sensory and motor latency variables 2 months after treatment was statistically meaningful, but no difference was observed between the laser group and the injection group comparing these variables.<sup>(17)</sup> Besides, similar to our study, no improvement in the sensory and motor amplitude variables was seen in that study. According to the similarity of the mentioned study to our investigation regarding study design, type and intensity of the therapeutic methods applied, it can be concluded that although there is no meaningful difference between the short term and long term effects of the laser and injection treatments, their effectiveness on pain severity and electrodiagnostic variables decrease over time, which can explain the necessity for repeating such treatments in long term. Failure in improving the sensory and motor amplitudes observed in both studies can indicate non-effectiveness of the laser and injection treatments on lost axons in the

median nerve fibers.

According to the changes in the severity of the disease (based on the electrodiagnostic grading) 10 months after accomplishment of the treatment, the severity of the disease was improved in 47.1% and increased in 11.8% of the patients in the injection group, while there was improvement in 51.6% and increase in 16.9% of the severity of the disease among the patients in the laser group. In the Reza Soltani study, there was improvement in the severity of the disease in 62.5% and 81% of the patients in injection and laser therapy groups, respectively, while no increase in such severity was reported.<sup>(17)</sup> Further increase in the severity of the disease in our study may be because of the time passed and decrease in the effectiveness of the therapeutic methods as well as the presence of the predisposing factors. With this reasoning, lack of increase in the severity of the disease in short term studies could be explained.

In our study, 10 months after accomplishment of the treatment, 38.7% of the patients in the laser group and 32.4% of the patients in the injection group became normal electrodiagnostically. In the study by Rezasoltani et al, 2 months after accomplishment of the treatment, 66.7% of the patients in the laser group and 43.5% of the patients in the injection group became normal electrodiagnostically,<sup>(17)</sup> which again confirms this fact that both of these treatments are more effective in short term. Interestingly, there was no meaningful difference between laser therapy and local injection of corticosteroid in both studies. In the study of Agarwal et al (2005), 50% of patients with mild CTS became normal electrodiagnostically after local injection of corticosteroid.<sup>(10)</sup> Considering that we included both mild and moderate cases of CTS in our study, the results are quite similar to each other.

Generally, the results regarding the effectiveness of the laser therapy are different in several studies. According to a review study (2006) of 7 studies, positive responses from the laser therapy were obtained in 5 investigations (84% improvement on average), and in the remaining 2, there were no positive effects of the laser therapy, which can be contributed to the low intensity of the laser applied (1.8 and 6 J/cm<sup>2</sup> versus 9, 12, 30 and 225 J/cm<sup>2</sup> applied in the other studies).<sup>(16)</sup> In a literature by Viera et al (2001), the therapeutic effect of the gallium-arsenic laser with wavelength of 920-940 nm applied for 15 minutes each session for 3 weeks in the patients with idiopathic CTS was studied. In this study, electrodiagnostic tests were performed before and immediately after the accomplishment of the treatment and the results were compared to each other. Despite the clinical improvement, no improvements in nerve conduction studies were reported in that study.<sup>(12)</sup> Viera et al concluded that laser did not affect on fibers which were assessed typically in the electrodiagnostic studies, but it might probably cause improvement in fine fibers.<sup>(12)</sup> Lack of change in the electrodiagnostic variables could be explained this way that still there was not enough time for the changes in these parameters to be occurred. In other words, with assumption of the laser effectiveness in the healing of nerve fibers, there was not enough time for the process of nerve fiber regeneration to be take place and as a result the evidence of improvement in the electrodiagnostic studies had not been reported.

In our investigation, the mean values of variable changes during treatment were not different meaningfully comparing the laser and the injection groups. Generally, it could be concluded that the low level laser therapy can be effective as local injection for the treatment of CTS even in long term (after 10 months). Considering that each of the laser or local injection therapies have their own defects and benefits (for example, laser therapy is a noninvasive method and is preferred to local injection which is an invasive procedure; however, the benefit of the injection is that it is administered in a single session, while the laser therapy is applied in 10 sessions over a 3-week period), laser therapy can be used as an effective and safe method in mild and moderate CTS, particularly in patients who do not tend to receive local injection procedures.

One of the limitations of our study is that the other

parameters such as the satisfaction of patients from the therapeutic processes have not been considered. Considering that currently, the laser therapy is not under the coverage of insurance, further assessment regarding the cost-effectiveness of the laser therapy and comparing it with local steroid injection and other commonplace treatments for CTS is another important issue that have not been considered in our study. Furthermore, according to this fact that the occupational and daily functional statuses of each patient have critical roles in aggravating the disease as well as responding to treatment (particularly the nonsurgical procedures), these factors also should have been considered in the study. Also, pain and electrodiagnostic assessments should have been taken in shorter intervals (e.g. every 3 months). Finally, considering a control group (only treated with splint), could have indicated the actual value of the laser therapy and local injection interventions on electrodiagnostic variables in long term.

## REFERENCES

1. Atroshi I, Gummesson C. Prevalence of carpal tunnel syndrome in general population. *JAMA* 1999; 282: 153-8.
2. Felicity G, Bruce A. What can family physicians offer patients with carpal tunnel syndrome other than surgery? *Ann Fam Med* 2004; No 3: 267-73.
3. Simovic D, Weinberg DH. Carpal tunnel syndrome. *Arch Neurol* 2000; 57: 754-5.
4. Swart MA. Carpal tunnel syndrome: An investigation in to the pain. *Ergonomics* 1998; Dec: 28-30.
5. Dawson DM. Entrapment neuropathies of the upper extremities. *N Eng J Med* 1993; 329: 2013-8.
6. Cotton P. Symptoms may return after carpal tunnel surgery. *JAMA* 1991; 265: 1021-2.
7. Marshall S, Tardif G, Ashworth N. Local corticosteroid injection for carpal tunnel syndrome. *Cochrance Database Syst Rev* 2002; 4: CD 001544.
8. Dammers JW, Veering MM. Injection with methyl-prednisolone proximal to the carpal tunnel: a randomized double blind trail. *BMJ*. 1999; 319: 884-6.
9. Celiker R, Arslan S. Corticosteroid injection vs NSAID drug and splinting in carpal tunnel syndrome. *AM J Phys Med Rehabil* 2002; 81: 182-6.
10. Agarwal V, Singh R, Sachdev A, et al. A prospective study of long-term efficacy of local methyl prednisolone acetate injection in the management of mild carpal tunnel syndrome. *Rheumatology (oxford)* 2005 May; 44 (5): 647-50.
11. Bakhtiary AH, Rashidy-Pour A. Ultrasound and laser

- therapy in the treatment of carpal tunnel syndrome. *Aus J Physiother* 2004; 50(3): 147-51.
12. Viera A, Puro E, Hamilton ML. Evaluation of motor and sensory neuroconduction of median nerve in patients with carpal tunnel syndrome treated with non-coherent light emitted by gallium-arsenic diodes. *Rev Neurol*, 2001 Apr; 32(8): 717-20.
  13. Irvine I, Chong SL, Amirjani N, Chan KM. Double-blind randomized controlled of low-level laser therapy in carpal tunnel syndrome. *Muscle Nerve* 2004 Aug; 30(2): 182-7.
  14. Dimitru D, Amato A.A, Zwart M.J: *Electrodiagnostic Medicine*. 2nd ed. Philadelphia: Hanley & Belfus, Inc; 2002. p.1058-70.
  15. Smith CF, Vangsness CT. Future of laser biostimulation in America today: Microlight830. *Proc SPIE* 1992 June; 1643: 275-76)
  16. Naeser MA. Photobiomodulation of pain in Carpal tunnel syndrome: review of seven studies. *Photomed Laser Surg* 2006 Apr; 24(2): 101-10
  17. Rezasoltani Z, Ghayoomi AA, Raeissadat A, Azma K, Kazempoor M, Najafi Sh. Study of short term effects of low level laser therapy (LLL) vs. local steroid injection on patients with carpal tunnel syndrome. *Journal of Army University of Medical Sciences of The I.R.Iran* 2008; 1(6): 91-97.