

Low Level Laser Vs. Open Carpal Tunnel Release for Treatment of Carpal Tunnel Syndrome

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ABSTRACT

Carpal tunnel syndrome (CTS), an entrapment neuropathy of the median nerve at the wrist, is one of the most common peripheral nerve disorders. The cause of idiopathic CTS remains unclear. The mainstay for CTS diagnosis remains clinically. Open carpal tunnel release is the standard treatment. Present study was conducted to evaluate the effectiveness of low level laser treatment (LLLT) for CTS. Fifty-four patients, with 60 symptomatic hands complaining of CTS were divided into two equal groups. Group (A), was subjected to LLLT by He-Ne laser (632.8nm), while group (B) was subjected to open carpal tunnel release. Clinical and nerve conduction studies were evaluated. LLLT has proved to be an effective, non-invasive treatment for CTS especially for early and mild-to-moderate cases when pain is the main presentation, while surgery could be preserved for advanced and chronic cases. Refinement of laser tool and introduction of other wavelengths make LLLT for CTS a subject of further investigations.

INTRODUCTION

Carpal tunnel syndrome (CTS), an entrapment neuropathy of the median nerve at the wrist, is one of the commonest peripheral nerve disorders of a general prevalence of about 1% [1]. Female preponderance varies from 23:1-3:1 [2,3].

There is an established link between raised intracarpal canal pressure and clinical CTS. Nerve injury is suggested to arise from intermittent pressure effects on median nerve circulation. Raised intracarpal canal pressure may be due to space-occupying lesions that are usually absent in most cases. In idiopathic CTS, the cause of increased canal pressure remains unclear. There seems to be an increase in the connective tissue within the carpal canal, mostly in the form of non-inflammatory synovial fibrosis of an unclear mechanism [4].

Recently, there is a controversy as regard the role of biochemical and structural processes in the increase of connective tissue with CTS. Several

studies suggested an increased expression of prostaglandin E₂ (PGE₂) and vascular endothelial growth factor (VEGF) in synovial tissue biopsy denoting a particular activity phase in disease progression [5]. Moreover, an increased expression of matrix metalloprotein-2 in small arterioles was correlated with pain intensity, which clarified that pain may be a more prominent feature of early CTS and not related to median nerve [6].

The mainstay for CTS diagnosis remains the clinical assessment of patient's history, with nocturnal paresthesia in median nerve distribution being the most characteristic symptom. Definite sensory and motor signs are elicited in more advanced cases [7,8]. Moreover, different clinical tests could be used to establish the diagnosis of CTS with different reported results [4].

Nerve conduction studies (NCSs) can help to confirm the diagnosis of CTS and to exclude other lesions. They had a lower sensitivity when compared with the clinical diagnosis, as 22% of clinically definite CTS cases had normal NCSs [9].

Imaging modalities are other promising investigations that could be used for diagnosis of CTS. The most sensitive morphologic finding is the expansion of the median nerve in or just proximal to the carpal tunnel with a cross-sectional nerve surface area >10.03mm² [10]. Other investigators confirmed, by the use of ultrasonic measurement, the risk of CTS with high wrist ratio (>0.7) [11] instead of external wrist dimensions [12]. However, it has not yet been clearly shown that imaging can offer any additional advantage regarding treatment selection [4].

Treatment of CTS could be categorized into non-surgical and surgical. Non-surgical treatment

includes; non-steroidal anti-inflammatory drugs (NSAIDs), local steroid injection, and wrist splinting [13]. On the other hand, surgical treatment for CTS means carpal tunnel release. The first open carpal tunnel release is credited to Learmonth in 1929 and was later popularized by Phalen and co-workers in the 1950s. Since then, open approach had been the standard treatment for CTS. However, to obviate its complications including hypertrophic or painful scars, and slow return of pinch and grip strength, endoscopic approach has been introduced by Okutsu and co-workers [14].

Occasionally, trials of alternative modalities for treatment of CTS are carried out. These include the introduction of low level laser treatment (LLLT) for CTS [15,16]. Many investigators demonstrated the potential beneficial effects of LLLT. These include enzymatic effects on acetylcholine esterase, stimulation of fibroblast proliferation, absolute increase of microcirculation, and stimulation of RNA, DNA, and ATP synthesis. Collectively, LLLT has proved to have analgesic, anti-inflammatory, and anti-oedematous effects on the bio-tissues [17,18].

As a consequence, the present study was conducted to evaluate the effectiveness of low level laser for treatment of CTS in comparison to the standard open carpal tunnel release.

PATIENTS AND METHODS

Fifty-four patients with 60 symptomatic hands complaining of CTS were studied. Investigated data included patients' demographic data, subjective complaints, history of previous interventions, physical examination, and NCSs.

Patients were divided into two equal groups (A and B). Each group included 27 patients with 30 affected hands taking into consideration that each bilaterally affected patient (n=6 patients) was included in one treatment group for one side and in the other treatment group for the contralateral side.

Group (A), Low Level Laser Treatment (LLLT):

This was done by use of He-Ne laser (632.8nm, level laser systems, M300), CW mode, at 20 Joule/cm². Each patient received 12 treatment sessions at a rate of 2 sessions/week. Each laser session lasted for 20 minutes. An area extending from proximal palmer crease to distal wrist crease, and laterally from scaphoid tuberosity to pisiform bone was exposed to LLLT through computerized scanning software.

Group (B), Open Carpal Tunnel Release:

Open surgical decompression was done by an incision gently curves from ulner border of palmaris longus tendon where it crosses the distal wrist crease and extends to the midpalm. The palmer fascia was incised to expose the transverse carpal ligament, which was then completely divided vertically at its midpoint (Figs. 1,2). The median nerve was inspected, and neurolysis may be carried out if the nerve was found to be adherent. Finally, only the skin was closed.

Demographic Data:

These included sex (female and male), age (mean \pm standard deviation, and range), hand dominance (right, left, and ambidextrous), work status (manual, non-manual), medical co - morbidities, and smoking. Medical co-morbidities included hypertension, diabetes mellitus, thyroid disease, cervical spine disease and previous hand trauma.

Subjective Complaints:

These included the affected side and duration of symptoms, pain, numbness, tingling, awaking from sleep by symptoms, muscle weakness, and exacerbation of symptoms by manual effort. Prior treatment and its effectiveness were reported.

Physical Examination:

These included hand and/or wrist scars, Tinel's sign, Phalen's sign, positive median nerve compression test, decreased light touch sensibility, and thenar atrophy. Finally, NCSs were carried out.

Post-Treatment Evaluations:

This included symptomatic relief, return to light and regular duty, and complications including those related to the scars among group (B). Once more, NCSs were carried out at the end of the follow up about 6 months after accomplishing the corresponding treatment. Statistical analysis was evaluated by Student's *t*-test with a statistical significance at $p < 0.05$.

RESULTS

I- Before Treatment:

1- Patients' Demographic Data:

Table (1) summarizes the patients' demographic data for all patients and for each group (A and B) separately. The mean age for all patients was 47.23 ± 6.52 years (range, 31 to 67 years). It was 49.11 ± 7.23 years (range, 38-67 years) for group (A), and 42.65 ± 8.05 years (range, 31-63 years) for group (B).

2- Subjective complaints:

45 patients (83.33%) had complaints on their right hands, and 3 patients (5.56%) on their left hands. Bilateral symptoms were found in the resting 6 patients (11.11%). All of those bilaterally affected patients experienced greater symptoms on their dominating right hands. Bilateral procedures were accomplished in 6 patients (11.11%), on the left side in 3 patients (5.56%), and on the right side for the resting 45 patients (83.33%). The duration of the presenting symptoms was 32.45 ± 6.12 months (range, 3-120 months). The duration of symptoms among group (A) was 28.21 ± 7.03 months (range, 6-84 months) and 36.17 ± 4.38 months (range, 3-120 months) among group (B). Table (2) shows the subjective complaints on the initial patients' presentations for all patients and for each group (A and B) separately.

3- Prior Interventions:

Splinting during work, at night, or all over the day were attempted in 15 patients (27.78%). NSAIDS were attempted in 11 patients (20.37%). None of the investigated patients had undergone prior local corticosteroid injection. All the patients who had undergone previous non-operative treatment had either no or minimal improvement of complaints.

2 patients (3.70%) reported prior carpal tunnel release by open approach on their dominating right side. Their presentations at the present study were for the symptomatic contralateral non-dominating left side.

4- Physical Examination:

All patients underwent an initial physical examination during their first visit after assessment of their subjective complaints. Scars were noticed on right hands of 2 patients (3.70%) of previous open carpal tunnel release. Table (3) shows the objective findings for all patients and for each group (A and B) separately.

5- Nerve Conduction Studies (NCSs):

All patients underwent pre-treatment NCSs. Positive NCSs were elicited in 48 affected hands (80%). The resting 12 symptomatic hands (20%) had negative results despite the physical findings consistent with the diagnosis of CTS and yet they were included on a clinically-based background. Table (3) shows NCSs' results for all patients and for each group (A and B) separately.

II- After Treatment:

All patients were re-evaluated for 6 months after accomplishing the corresponding treatment on monthly-based visits. Regarding group (A), there were no restrictions neither towards return to work with one-handed duty nor towards return to light duty work. On the contrary, among group (B), patients were allowed to return to work with one-handed duty restrictions about 2-3 days after surgery, and after 3 weeks, return to light duty work started. However, regular duty work was accomplished after 6 weeks for both groups after the end of the corresponding treatment. Subjective complaints and objective findings including NCSs results for both groups were summarized in Tables (4,5) respectively.

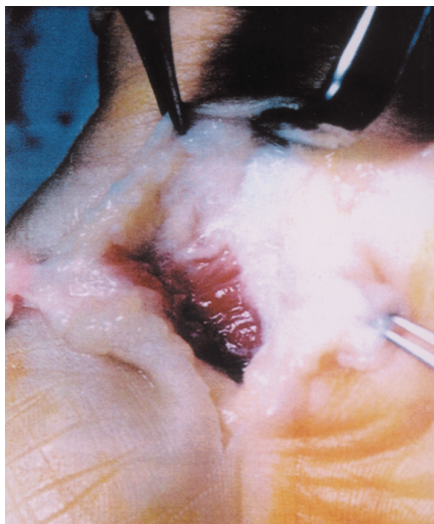


Fig. (1): Open carpal tunnel release. Skin is retracted showing the transverse carpal ligament.

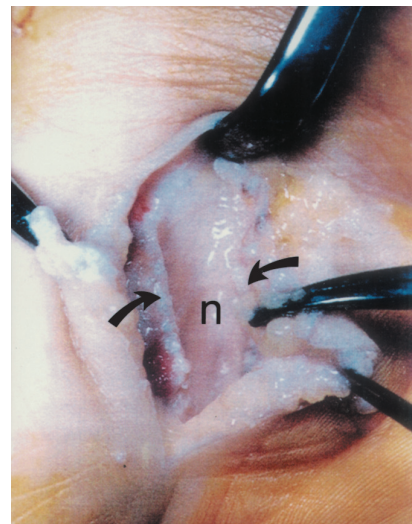


Fig. (2): Open carpal tunnel release. Skin is retracted. Transverse carpal ligament (arrowhead) is divided exposing the median nerve (n) at the depth of the wound.

Table (1): Patients' demographic data. Group (A) is the laser treated group and group (B) is the surgically treated group.

Patients' demographic data	All patients (n=54)		Group (A) (n=27 patients)		Group (B) (n=27 patients)	
	No.	%	No.	%	No.	%
<i>Sex:</i>						
Female	48	88.89	25	92.59	23	85.18
Male	6	11.11	2	7.41	4	14.82
<i>Hand dominance:</i>						
Right-handed	53	98.15	26	96.30	27	100
Left-handed	1	1.85	1	3.70	0	0
Ambidextrous	0	0	0	0	0	0
<i>Employment type:</i>						
Manual	53	98.15	26	96.30	27	100
Non-manual	1	1.85	1	3.70	0	0
<i>Co-morbidities:</i>						
Hypertension	3	5.56	1	3.70	2	7.41
Diabetes mellitus	5	9.26	3	11.11	2	7.41
Thyroid disease	0	0	0	0	0	0
Cervical spine Dis.	0	0	0	0	0	0
Prior hand trauma	0	0	0	0	0	0
<i>Smoking status:</i>						
Smokers	2	3.70	0	0	2	7.41
Non-smokers	52	96.30	27	100	25	92.59

Table (2): Subjective complaints before treatment. Group (A) is the laser treated group and group (B) is the surgically treated group.

Subjective complaints	Overall (n=60 hands)		Group (A) (n=30 hands)		Group (B) (n=30 hands)	
	No.	%	No.	%	No.	%
Pain	31	51.67	17	56.67	14	46.67
Tingling	55	91.67	26	86.67	29	96.67
Numbness	58	96.67	29	96.67	29	96.67
Night awakening	42	70	20	66.67	22	73.33
Muscle weakness	17	28.33	7	23.33	10	33.33
Sympt exacerbation	48	80	25	83.33	23	76.67

Table (3): Objective findings before treatment. Group (A) is the laser treated group and group (B) is the surgically treated group.

Objective findings	Overall (n=60 hands)		Group (A) (n=30 hands)		Group (B) (n=30 hands)	
	No.	%	No.	%	No.	%
Median nerve Compression	50	83.33	23	76.67	27	90
Decreased light Touch	42	70	22	73.33	20	66.67
Thenar atrophy	16	26.67	6	20	10	33.33
Positive Phalen's	17	28.33	7	23.33	10	33.33
Positive Tinel's	20	33.33	9	30	11	36.67
Positive NCSs.	48	80	20	66.67	28	93.33

Table (4): Subjective complaints before and after treatment. Group (A) is the laser treated group and group (B) is the surgically treated group.

Subjective complaints	Group (A) (n=30 hands)			Group (B) (n=30 hands)		
	Before treatment	After treatment	<i>p</i> value	Before treatment	After treatment	<i>p</i> value
Pain	17	3	<0.01	14	1	<0.001
Tingling	26	3	<0.01	29	1	<0.001
Numbness	29	3	<0.01	29	1	<0.001
Night awakening	20	3	<0.01	22	0	<0.001
Muscle weakness	7	5	N.S.	10	5	N.S.
Sympt exacerbation	25	3	<0.01	23	0	<0.001

Note: N.S. is not significant.

Table (5): Objective findings before and after treatment. Group (A) is the laser treated group and group (B) is the surgically treated group.

Objective findings	Group (A) (n=30 hands)			Group (B) (n=30 hands)		
	Before treatment	After treatment	<i>p</i> value	Before treatment	After treatment	<i>p</i> value
Median nerve compression	23	3	<0.01	27	1	<0.001
Decreased light touch	22	3	<0.01	20	1	<0.001
Thenar atrophy	6	5	N.S.	10	5	N.S.
Positive Phalen's	7	1	<0.01	10	0	<0.001
Positive Tinel's	9	0	<0.01	11	0	<0.001
Positive NCSs.	20	8	<0.01	28	6	<0.01

Note: N.S. is not significant.

DISCUSSION

Regarding patients' demographic data at the present study, the female/male ratio was found to be 8/1. The majority of our patients were manually employed. Regarding the correlation between hand dominance and symptomatic side, we found that the majority of symptoms were related to the dominating side. All of the 6 bilaterally affected patients had experienced greater symptoms on their dominating right hands. 45 unilaterally symptomatic patients were on their dominating right hands. The resting 3 patients were unilaterally symptomatic on the left side from whom one patient was left-handed dominance, while the other 2 patients were after prior surgical release on their contralateral dominating right side. These findings are widely accepted with those previously reported [2-4,7].

Regarding success evaluation, it is important to temper results for each group by its corresponding pretreatment assessment. Although our patients exhibited variable statistically significant results, there was uniformly high patient satisfaction regardless the treatment group.

Regarding patients' subjective complaints, all patients had satisfactory outcome at different statistical significances. The only exception was regarding muscle weakness. Fortunately, the majority of our patients presented with pain, tingling,

and numbness. This was not a surprise as was frequently reported at previous studies [15,16]. Moreover, regarding the objective findings including NCSs, all patients had satisfactory results at different statistical significances. The only exception was regarding thenar atrophy.

The non-significant results as regard muscle weakness and thenar atrophy for patients among group (B) are the same as was previously reported. It was reported that patients with more advanced disease presenting with weakness and muscle atrophy are associated with less favorable surgical outcome [14]. Application of this statement also for our results among group (A) makes advanced CTS patients must be cautioned to expect a longer and possibly incomplete neurological recovery regardless of the treatment modality.

Moreover, 12 affected hands (20%) in the present work had negative NCSs and even were treated on a clinically-based background. It was reported that NCSs have lower sensitivity compared to the clinical diagnosis as 22% of clinically definite CTS patients had normal NCSs [9].

Residual and/or recurrent symptoms after carpal tunnel release may result from incomplete release of the transverse carpal ligament, fibrous proliferation, scarring within the tunnel, entrapped palmar cutaneous nerve, and painful scar [13]. On the other

hand, unrelieved or recurrent symptoms after LLLT may be due to incomplete control of CTS pain [16]. In the present study, there were 3 patients (10%) and only 1 patient (3.33%) among group (A) and (B) respectively who experienced residual and/or recurrent symptoms after treatment. The residual and/or recurrent symptoms among group (B) were not only less frequent than those among group (A), but also they were transient, occasional, and markedly attenuated. This was denoted by the disappearance of night awakening and symptom exacerbation among group (B) rather than among group (A).

The existing controversy regarding the safety of open carpal tunnel release, was noticed to be a personally dependent. Fortunately, scar-related complications among group (B) were our only complications. There were occasional scar tenderness in 3 hands (10%) and scar hypersensitivity to touch, cold and/or heat in 1 hand (3.33%). This is statistically acceptable when compared with the previously reported [4,13].

Conclusion:

LLLT has proved to be an effective, non-invasive treatment for early and mild-to-moderate cases of CTS when pain is the main patient's presentation, while surgery could be preserved for advanced and chronic cases. Moreover, LLLT may be suggested for treatment of residual pain after surgically released carpal canal.

Refinement of laser tool and introduction of other wavelengths make LLLT for CTS a subject of further investigations. Since then, carpal tunnel release is still the standard treatment for CTS taking into consideration that its complications may be overcome by the introduction of endoscopic approach that should be addressed for further evaluation.

Acknowledgement:

The authors thank Mrs. Reham Shahin, M.Sc., National Institute of Laser Enhanced Sciences, Cairo University, for her effort during provisional conduction of LLLT for CTS. Finally, we express our appreciation for the staff members of Clinical Neurophysiology Department, Faculty of Medicine, Cairo University for their aid during NCSs.

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