International Journal of ChemTech Research
CODEN(USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.5, pp 718-724,2017

Effect of High Intensity Laser Therapy on Cubital Tunnel Syndrome

*[1]Maher A. El-Keblawy, [1]Ghada Ismail Mohamed,
[2]Ibrahim Mohamed IbrahimZoheiry, [2]Nada Mohamed El Missiry

[1]Department of Basic Science ,Faculty of Physical Therapy , Cairo University, Cairo, Egypt.
[2]Physical Therapy Department for Surgery, Faculty of Physical Therapy, October 6University, Cairo, Egypt.
Damnhour teaching hospital

Abstract: Cubital tunnel syndrome is the second most common peripheral entrapment neuropathy after carpal tunnel syndrome. Patients with cubital tunnel syndrome often complain of numbness in the ulnar side of hands and parathesia of elbow, these symptoms can be exacerbated by elbow flexion. Purpose of the study was to investigate effect of high intensity laser therapy (HILT) on cubital tunnel. Thirty patients with cubital tunnel syndrome were randomly assigned to a HILT group and placebo HILT group. The study was designed as a randomized clinical trial. Each participant in the 2 groups received 20 treatment sessions of HILT or placebo HILTtherapy over a period of 4 consecutive weeks. Outcome measures were the visual analouge Scale (VAS) and nerve conduction study (NCS) measured pre and post treatment program. Patients with HILT group showed significant improvement in pain and nerve conduction velocity while patient with placebo HILT group show improvement in pain only.High intensity laser was recently introduced to the field as a significant effective therapy modality.

Keywords: Cubital tunnel syndrome, High intensity laser treatment, Visual analogue scale, Nerve conduction study.

Introduction

Cubital tunnel syndrome (CUTS) is entrapment of ulnar nerve in the cubital tunnel. It is the second most common entrapment neuropathy of the upper extremity, after carpal tunnel syndrome.[1,2,3]

Incidence of cubital tunnel syndrome in the general population has been reported at 24.7 per 100,000. Populations at risk for cubital tunnel syndrome include patients with diabetes, obesity, as well as occupations involving repetitive elbow flexion and extension, holding tools in constant positions and using vibrating tools[4]

Patients present with intermittent parasthesias, numbness and tingling in the small finger and ulnar half of the ring finger. As the disease progresses, the symptoms become constant and patients may complain of elbow pain around cubital tunnel, non-specific complaints of hand clumsiness or weakness and atrophy of the intrinsic hand muscles innervated by the ulnar nerve [5]

Four categories exist with regard to the clinical grading of CUTS.Grade I represents minimal weakness of ulnar innervated forearm and intrinsic hand muscles, no pain or atrophy,Grade II: Minimal weakness of ulnar innervated forearm and intrinsic hand muscles with pain and/or atrophy. Grade III: Moderate weakness of intrinsic hand muscles with atrophy and/or prominent tenderness or Tinel's sign on nerve palpation and percussion. Grade IV: Marked weakness of ulnar innervated forearm and intrinsic hand muscle with severe muscle atrophy[6]

Visual Analogue Scale (VAS) measures acute and chronic pain and has been validated in several studies. A VAS comprises of a 10cm line, with start and end points of no pain and the worst pain. A VAS may also have specific labels with intensity denoted by numbers or adjectives and these are referred to as Graphic Rating Scales (GRS). When applying the VAS, individuals indicate which point on the line best indicates their pain level. The length from the no pain (i.e. start point) to the mark made by the individual is scored as their particular pain level. The scale is measured in millimetres (1 – 10) and so is considered to have 101 points[7,8,9]

Nerve conduction studies are most often used diagnostic tool for peripheral nervous system disorders. The nerve conduction velocity is the speed at which an electrical stimulus passes through the nerves. The nerve conduction velocity relies on the fiber diameter, de-myelination degree and internodal distance. Motor nerve conduction studies require stimulation of a peripheral nerve while using a recording from a muscle innervated by the nerve. Sensory nerve conduction studies performed by stimulating a mixed nerve while recording from a mixed or cutaneous nerve[10]

High Intensity Laser Therapy (HILT) is a recent rehabilitation therapy successfully used in orthopedic diseases and sports medicine, due to its fast efficacy, with rapid and permanent relief of pain and the resulting reduction of the recovery time. The most important physiological effects of HILT are increase in the activity of many intracellular enzymes, specifically in the Krebs cycle, increase of oxygen transportation and also, of glucose utilization, stimulation of DNA synthesis, activation of the Na/K membrane pumps, increase of fibroblast activity, increase of phagocytosis activation, activation of metabolic cellular processes, local changes in some important inflammation mediators (such as histamine and prostaglandins) and in endorphin levels. The most important clinical effects are: analgesia and biostimulation[11,12,13]

The analgesic effect is produced by high-power pulsed applications, which create inside the body photomechanical waves that reach the subcutaneous pain receptors, stimulate the A fibers and close the gate for pain transition (according to the gate control theory described by Melzack). The biostimulation effect is the ability to biostimulate cell growth and cell repair[14,15,16]

Considering the reported effectiveness of HILT in the treatment of musculoskeletal pain, the aim of the current study was to investigate the effect of High intensity laser oncubital tunnel syndrome.

Subjects:

Thirty patients diagnosed with unilateral cubital tunnel syndrome (moderate degree) from both sexes were indulged in this study, their age ranged from 20 to 40 years.

The patients were divided into 2 groups of equal number, Group (A) contained 15 cubital tunnel syndrome patients who received high intensity laser therapy, while Group (B) contained 15 cubital tunnel syndrome patients who received placebo and same medical treatment (Nonsteroidalanti inflammatory drugs and Vitamin B12).

Participants with factors resulting in symptoms similar tocubitaltunnel syndrome such as arthritis, fluid retention in pregnancy, hyperthyroidism, traumatic changes, and prior injury to the elbow were excluded from the study.

Patients were evaluated at base line before treatment and after completion of treatment usingNeuropack S1 MEB-9004 NIHON KODEN, JAPAN for measuring the motor conduction velocity of the ulnar nerve across elbow. Visual analogue scalewas used to measure pain on a 10 cm horizontal axis between a left end point of " no pain " and a right end point of " worst pain ever". The distance was measured and pain was recorded on a 0 point scale.

Procedures:

Table(1): High intensity laser parameters used:

Wave length:	**1064 nm**
Peak power	3 kW
Energy density:	360-1780 mJ/cm^2
Duration	120-150 Ms
Mean Power	10.5 w
Frequency	10-40 Hz
Duty cycle	0.1%
Probe diameter	0.5 cm
Spot size	0.2 cm^2
Total energy delivered to the patient during one session	1275 J.

- Patients in the group (A)received high intensity laser as explained in table (1).
- Treatment protocol:

A standard handpiece endowed with fixed spacers was used to provide the same distance to the skin and perpendicularly to the zone to be treated with a laser beam diameter of 5 mm. Three phases of treatment were performed for every session. The total energy that was delivered to the patient during one session was 1275 J through three phases of treatment.

The first phase involved fast manual scanning (100 cm2 per 30 s) around medial epicondyle and flexor muscles extending over forearm from medial epicondyle. Scanning was performed in both transverse and longitudinal directions. In this phase, a total energy dose of 625 J was administered. In the first phase, the laser fluency was set to three subphases of 510 mJ/cm2 (208 J), 810 mJ/cm2 (208 J), and 970 mJ/cm2 (209 J), for a total of 625 J.

The second phase involved applying the handpiece with fixed spacers vertically to 90° on CFT near the medial epicondyle (trigger point inactivation phase). The second phase was carried out on CFT with a frequency of 360 mJ/cm2 (6 J), 510 mJ/cm2 (9 J), and 610 mJ/cm2 (10 J) and a time of 6 s at each time, for a total of 25 J.

The third phase involved slow manual scanning (100 cm2 per 60 s) of the same areas treated in the first phase until a total energy dose of 625 J was achieved .The application time for one session was approximately 15 min with the total energy delivered to the patient during one session of 1275 J.

The energy received in each phase and the total energy delivered to the patient during the treatment session will be calculated by the device. All laser applications were performed by the same physiotherapist.

- Frequency of treatment: Treatment was given 5 times / week for 20 sessions.

Statistical analysis:

Statistical analysis was conducted using SPSS for windows, version 20 (SPSS, Inc., Chicago, IL). Normality test of data using Shapiro-Wilk test was used, that reflect the data was normally distributed for nerve conduction velocity, so parametric statistical tests in the form of (paired t test) was used to compare between "pre" and "post" treatment for each group and "unpaired t test" was conducted to compare nerve conduction velocity between both groups in the “pre” and “post” treatment. While, normality test of data using Shapiro-Wilk test was used, that reflect the data was not normally distributed for pain level, so non parametric statistical tests in the form of (Wilcoxon Signed Rank tests) was used to compare between "pre" and "post" treatment for each group and "Mann-Whitney tests" was conducted to compare pain level between both groups in the “pre” and “post” treatment. The alpha level was set at 0.05.

Results

- **Baseline and demographic data**

There were no statistically significant differences (P>0.05) between subjects in both groups concerning age and BMI (Table 2).

Table (2): Physical characteristics of patients in both groups.

Items	Group A	Group B	Comparison		S
	Mean ± SD	Mean ± SD	t-value	P-value	
Age (yrs)	28.06±2.28	28.4±3.20	-0.328	0.745	**NS**
BMI (Kg/m^2)	23.26±0.40	23.11±0.44	0.942	0.354	**NS**

***SD: standard deviation, P: probability, S: significance, NS: non-significant.**

- **Nerve conduction velocity:**

Regarding within group's comparison, statistical analysis using"Paired t test" revealed that there was a significant increase in nerve conduction velocity at post treatment in compare to pre treatment at both groups with (p < 0.05). Table (2) present descriptive statistic (mean±SD) and comparison tests (within and between groups) for nerve conduction velocity.Considering the effect of the tested group (first independent variable) onnerve conduction velocity,"unpaired t test" revealed that there was significant difference between both groups at post treatment (p<0.05) and this significant increase in favour to group A.

Table (3): Mean ±SD and p values of nerve conduction velocity pre treatment and post treatment test at both groups.

Nerve conduction velocity	Means ± SD	Means ± SD	Mean difference	% of improvement	t-value	P- value
	Pre test	Post test				
Group A	43.91±2.18	55.77±1.35	-11.86	27	-32.54	0.0001*
Group B	43.88±2.19	44.62±2.17	-0.74	1.68	-7.351	0.0001*
Mean difference	0.03	11.15				
t-value	0.038	16.879				
P- value	0.97	0.0001*				

***Significant level is set at alpha level <0.05**.

- **Pain level:**

Regarding within group's comparison, statistical analysis usingWilcoxon Signed Rank tests revealed that there was a significant reduction in pain level at post treatment in compare to pre treatment at both groups with (p < 0.05). Table (3) present descriptive statistic (median) and comparison tests (within and between groups) for pain level.Considering the effect of the tested group (first independent variable) on pain level, "Mann-Whitney U test" revealed that there was significant difference between both groups at post treatment (p<0.05) and this significant reduction in favour to group A.

Table (4) Median, U, Z, and p values of pain level pre and post test at both groups.

Pain level	Pre test	Post test	Z-value	p- value
	Median	Median		
Group A	6	1	-3.501	0.0001*
Group B	6	3	-3.473	0.001*
U-value	112.5	1		
Z-value	0.000	-4.735		
p- value	1.00	0.0001*		

*Significant level is set at alpha level <0.05 p-value: probability value

Discussion:

In the present study we compared between the results of two groups received the same medical treatment for four consecutive weeks. The first group (A) had been received HILT in addition to medical treatment while group B received sham HILT in addition to the same medical treatment.

Nerve conduction velocity study had been done by Neuropack S1 MEB-9004 NIHON KHODEN, Japan. NCS is used as a standardized testing tool for diagnosis of cubital tunnel syndrome due to its objectivity in providing information on the physiological health of the ulnar nerve across the cubitaltunnel**.** The standard diagnosis technique is comparing the motor conduction velocity of the ulnar nerve across the elbow joint. [17,18]

Pain was evaluated before and after treatment for the two groups using the visual analogue scale The VAS will be to measure pain on a 10 cm horizontal axis between a left end point of " no pain " and a right end point of " worst pain ever". The distance is measured and pain is recorded on a 0 point scaleVisual analogue scale is valid and reliable tool in evaluation of pain.

Concerning nerve conduction velocity, group A showed improvement in conduction velocity from **43.91±2.18**to **55.77±1.35**m/sec as shown in **table (3)**whichcan be explained by increase in the activity of many intracellular enzymes, specifically in the Krebs cycle, increase of oxygen transportation and glucose utilization, stimulation of DNA synthesis, activation of the Na/K membrane pumps, increase of fibroblast activity. All of these effects contribute to better transmission of nerve impulse in addition to improvement in nerve physiological properties which reflect on nerve conduction velocity.

HILT can also impact healing of peripheral nerves indirectly by accelerating inflammatory stage which can be explained by reduction of pro inflammatory cytokines (such as Interleukin-1 Alpha and Interleukin-1 Beta), production of transforming growth factor-beta and platelet derived growth factor which inhibit release of prostaglandins leading to improved healing and repair.

Dilatation of arterial and capillary vessels is one of the major effects of HILT, this contributes to increased microcirculation, angiogenesis and nerve regeneration which help optimizing nerve function and improving nerve conduction velocity as reported by **Taradaj.**[19]

Our findings were supported by **Elayat et al.,** [20]who investigated efficiency of HILT and LLLT on Bell's palsy, their results showed significant difference in favor of HILT as it has more penetration and higher intensity which allow better absorption rate leading to increased mitochondrial oxidative reaction, ATP, DNA and RNA production, all of these physiological effects lead to enhanced rate of facial nerve recovery.[20]

Further explanation was presented by **Rochkind et al.,** [21] who studied influence of laser therapy on peripheral nerve injuries in rats, they reported that Laser promote proliferation of glial cells in both astrocytes and oligodenderocytes. This leads to higher neuron metabolism and better myelin production which in turn improves nerve conduction velocity.[21]

In the present study, group (A) showed more significant improvement than group (B) in regards to pain relief **(U = 1, Z = -4.735, and P= 0.0001)** as shown in **table (4)** which can be explained by HILT analgesic effect produced by high power pulsed applications that create photomechanical waves and thus reach subcutaneous pain receptors, HILT can also stimulates A fibers and close pain gate resulting in pain relief. Production of endorphine and enkephaline in response to HILT helps in elevation of pain threshold. Also we can postulate that HILT can control inflammatory process which leads to indirect relief of pain.

Our results were supported by **Tache-Codreanu et al.,**[22] who highlighted the efficiency of High intensity laser therapy on pain gate through stimulation of Afibers. Further explanation was shown by **Dundar et al.,** [23]performed a study to investigate effect of HILT on lateral epicondylitis while comparing it with brace and sham laser. They found out that HILT showed significant difference in controlling pain and inflammation as it managed to slow down pain impulses and increased production of morphine-mimetic substances in the body.[22,23]

Conclusion:

We can conclude that High intensity laser leads to improvements in ulnar nerve conduction velocity and pain relief in patients suffering from cubital tunnel which can be explained by anti-inflammatory and biostimulation properties of HILT as well as better penetration depth and absorption rate.

References

1. Dawson, D. M. (1993). Entrapment neuropathies of the upper extremities. *New England Journal of Medicine*, *329*(27), 2013-2018.
2. Idler, R. S. (1996). General principles of patient evaluation and nonoperative management of cubital syndrome. *Hand clinics*, *12*(2), 397-403.
3. Bartels, R. H., Verhagen, W. I., van der Wilt, G. J., Meulstee, J., van Rossum, L. G., &Grotenhuis, J. A. (2005). Prospective randomized controlled study comparing simple decompression versus anterior subcutaneous transposition for idiopathic neuropathy of the ulnar nerve at the elbow: Part 1. *Neurosurgery*, *56*(3), 522-530.
4. Trehan, S. K., Parziale, J. R., &Akelman, E. (2012). Cubital tunnel syndrome: diagnosis and management. *Medicine and Health Rhode Island*, *95*(11), 349.
5. Palmer, B. A., & Hughes, T. B. (2010).Cubital tunnel syndrome. *The Journal of hand surgery*, *35*(1), 153-163.
6. St John, J. N., &Palmaz, J. C. (1986).The cubital tunnel in ulnar entrapment neuropathy. *Radiology*, *158*(1), 119-123.
7. Katz, J., &Melzack, R. (1999). Measurement of pain. *Surgical Clinics of North America*, *79*(2), 231-252.
8. Carlsson, A. M. (1983). Assessment of chronic pain. I. Aspects of the reliability and validity of the visual analogue scale. *Pain*, *16*(1), 87-101.
9. Huskisson, E. C., JONES, J., & SCOTT, P. J. (1976). Application of visual-analogue scales to the measurement of functional capacity. *Rheumatology*, *15*(3), 185-187.
10. Gakhar, M., Verma, S. K., &Lehri, A. (2014). A comparison of nerve conduction properties in male and female of 20 to 30 years of age group. *Journal of Exercise Science and Physiotherapy*, *10*(1), 16.
11. Fortuna, D., Zati, A., Mondardini, P., Ronconi, L., Paolini, C., Bilotta, T. W., &Masotti, L. (2002). Low Level Laser Therapy (LLLT) edefficaciaclinica. Studi in doppiociecorandomizzato a confronto. *Medicinadello sport*, *55*(1), 43-50.
12. Junior, E. C. P. L., Lopes-Martins, R. Á. B., Baroni, B. M., De Marchi, T., Taufer, D., Manfro, D. S., ... & Marcos, R. L. (2009). Effect of 830 nm low-level laser therapy applied before high-intensity exercises on skeletal muscle recovery in athletes. *Lasers in medical science*, *24*(6), 857.
13. Santamato, A., Solfrizzi, V., Panza, F., Tondi, G., Frisardi, V., Leggin, B. G., ...& Fiore, P. (2009). Short-term effects of high-intensity laser therapy versus ultrasound therapy in the treatment of people with subacromial impingement syndrome: a randomized clinical trial. *Physical therapy*, *89*(7), 643.
14. Tunér, J., &Hode, L. (1998). It's all in the parameters: a critical analysis of some well-known negative studies on low-level laser therapy. *Journal of clinical laser medicine & surgery*, *16*(5), 245-248.
15. Prouza, O., Jeníček, J., &Procházka, M. (2013). Class 4.non-invasive laser therapy in clinical rehabilitation. *Rehabil.fyz. Lék*, *20*(2), 113-119.
16. Pryor, B. A. (2011). Advances in Laser Therapy for the Treatment of Work Related Injuries. *Current Perspectives in Clinical Treatment and Management in Workers' Compensation Cases*, 191.
17. Dhavalikar, M., Narkeesh, A., & Gupta, N. (2009). Effect of skin temperature on nerve conduction velocity and reliability of temperature correction formula in Indian females. *Journal of Exercise Science and Physiotherapy*, *5*(1), 24.
18. Mallik, A., & Weir, A. I. (2005). Nerve conduction studies: essentials and pitfalls in practice. *Journal of Neurology, Neurosurgery & Psychiatry*, *76*(suppl 2), ii23-ii31.
19. Taradaj, J. (2001). Lasers in medicine and rehabilitation. *Fizjoterapia*, *9*(4), 42-47.
20. Alayat, M. S. M., Elsodany, A. M., & El Fiky, A. A. R. (2014). Efficacy of high and low level laser therapy in the treatment of Bell's palsy: A randomized double blind placebo-controlled trial. *Lasers in medical science*, *29*(1), 335-342.
21. Rochkind, S., Vogler, I., & Barr-nea, L. (1990). Spinal cord response to laser treatment of injured peripheral nerve. *Spine*, *15*(1), 6-10.

22. Tache-Codreanu, D. L., Murgu, A. I., &Marinescu, L. D. (2010). The possible side effects of High Intensity Laser Efectele adverse posibile ale laserului de înaltăintensitate. *PALESTRICA MILENIULUI III*, 219.
23. Dundar, U., Turkmen, U., Toktas, H., Ulasli, A. M., &Solak, O. (2015). Effectiveness of high-intensity laser therapy and splinting in lateral epicondylitis; a prospective, randomized, controlled study. *Lasers in medical science*, *30*(3), 1097-1107.

*****