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Effect of High-Power Laser Therapy on Pain and Electrophysiological Study in Cervical Radiculopathy Patients: A Randomized Controlled Trial

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Abstract

Background: Cervical radiculopathy (CR) is a disabling condition that has a significant negative impact on the mental health, physical functioning, and social participation.

Aim of Study: To determine the effect of high-power laser therapy (HPLT) on pain and electrophysiological study in patients with cervical Radiculopathy.

Patients and Methods: Twenty patients with cervical radiculopathy caused by disc prolapse at the level of C5-C6 or C6-C7 from both genders participated in this study after signing a consent form. The patients were randomly assigned into two equal groups; group A (study group) consisted of ten patients who received high power laser therapy (HPLT) for eight minutes in addition to selected physical therapy program (hot pack, US for 5min, exercise for 20min), group B (control group) consisted of ten patients who received the same selected physical therapy program only for eight sessions. All patients attended the physical therapy clinic two times weekly for four weeks. The evaluation for pain intensity was done by visual analogue scale (VAS). Sensory and motor nerve conduction studies and F wave for median and ulnar nerves of the affected upper extremity was recorded. Needle electromyography (EMG) for biceps brachii, triceps and first dorsal interosseus muscles was performed. All measurements were performed before and after the treatment.

Results: The results revealed that there was significant decline in VAS after treatment compared to pre-treatment results in both study and control group (p=0.005 & p=0.017; respectively). The study group showed a statistically significant lower values of VAS after treatment in comparison to the control group (p=0.010). However, there were no significant changes of the motor distal latency, distal motor amplitude, proximal motor amplitude, motor NCS, sensory distal latency, sensory distal amplitude and sensory NCS of both median and ulnar nerves after treatment when compared to pre-treatmentin both study and control group (p>0.05). Also, the results of F wave latency of both median and ulnar nerves and EMG of biceps, triceps and first dorsal interosseous muscles showed that, there was no significant difference after treatment when compared to pre-treatment results in both study and control group (p>0.05).

Conclusion: It can be concluded that HPLT is an effective noninvasive physical therapy modality inreducing pain in patients with cervical radiculopathy, However, The HPLT has no significant effect on the findings of electrophysiological studies.

Key Words: *High power laser therapy – Cervical radiculopathy – Electrophysiological study – F wave.*

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Introduction

CERVICAL radiculopathy (CR) is a condition involving a pathologic process affecting the cervical nerve roots. Commonly, this process is a herniated nucleus pulposus that anatomically compresses a nerve root within the spinal canal. Another common cause of radiculopathy is spinal stenosis resulting from a combination of degenerative spondylosis, ligament hypertrophy, and spondylolisthesis. Inflammatory radiculitis is another pathophysiological process that can cause radiculopathy **[1]**.

A combination of factors including pressure, inflammation, and an immune response seem to be implicated in the pathogenesis of both acute and chronic radicular pain. Pressure would not be a cause of pain, but rather of nerve dysfunction such as weakness and numbness, while the addition of both inflammation and immune response could explain the severe pain experienced by patients suffering from radicular pain **[2]**.

In recent years various studies have shown that the herniated tissue is not an inert material, but rather it is biologically very active with the capa-

bility of expressing a series of inflammatory mediators: Cytokines such as interleukin-1, interleukin-6, interleukin-8, and tumor necrosis factor being the ones which stand out. The inflammation is not only induced by the chemical irritation of the bioactive substances released by the nucleus pulposus but also by an autoimmune response against itself. Thus, in addition to the mechanical factor, the biochemical mediation plays an important role in the pathophysiology of pain [3].

Electrodiagnostic examination consisting of nerve conduction studies (NCS), and electromyography (EMG) is important in the diagnosis of radiculopathy because it gives information about the level of radiculopathy, as well as the pathophysiology of the resulting process. EMG keeps its strategic role because it demonstrates the severity and course of the event [4]. Needle electromyography is considered the hallmark diagnostic sign and the most accurate electrophysiologic procedure for establishing the diagnosis of cervical radiculopathy [5].

High power laser therapy (HPLT) is a new, non-invasive, painlessintervention which is characterized by its effective anti-inflammatory and reparative mechanisms. HPLT has therapeutic benefits through photochemical, photothermal, and photomechanical mechanisms, possibly due to its potential for reducing inflammation, enhancing microcirculation, and stimulating immunological proteins and nerve regeneration and secretion of 0-endorphins [6].

In high power laser therapy (HPLT), there is an increase in mitochondrial oxidative reaction and adenosine phosphate, DNA, and RNA production (photobiology effect). The pain releasing effect of HPLT is provided by reducing the transmission of painful stimuli and increased morphine mimetic factors. It has been reported that HPLT reduces pain and inflammation rapidly. Additionally, it has rapidly induced the photochemical and photothermal effects, increasing blood flow, cell metabolism, and vascular permeability [7].

There are studies in the literature showing the efficacy of HPLT in patients with chronic neck pain. However, in patients with chronic cervical radiculopathy, the literature is limited in terms of HPLT treatment. So, this study aimed to determine the effect of high-power laser therapy (HPLT) on pain and electrophysiological parametersin patients with cervical radiculopathy.

Material and Methods

Patients:

Twenty patients with cervical radiculopathy caused by disc prolapse at the level of C5-C6 or C6-C7 from both genders were selected from outpatient clinic of Faculty of Physical Therapy, Cairo University and outpatient clinic of Kasr Al-Aini Hospitals, in the period from August 2022 to January 2023.

Ethical consideration:

The study was conducted in concordance with the international ethical standards and applicable local regulatory guidelines. The study was reviewed and approved by the Research Ethical Committee, Faculty of Physical Therapy, Cairo University (No: P.T.REC/012/003 963).

All participants signed a written consent form after receiving full information about the purpose of the study, procedure, possible benefits, privacy and use of data and their rights to withdraw from the study whenever they want.

Registration:

The study protocol was registered on the Clinical Trail Registry (trail registration number: NCT05852613).

Sample size:

Sample size calculation is performed using G*POWER statistical software (version 3.1.9.2; Franz Faul, University Kiel, Germany) and revealed that the required sample size for this study is N=20.

Selection criteria for patients:

Inclusion criteria:

The following criteria were used to select patients of both genders with cervical radiculopathy due to disc prolapse at the level of C5-C6 or C6-C7 who was diagnosed on the basis of clinical (history and physical examination) and radiological examination (MRI) as well as EMG and nerve conduction studies findings. Their age ranged from 30 to 50 years. The patients had sensory changes such as pain and paresthesia (numbness, tingling, burning) in the upper extremity. Duration ranged from (3-12) months.

Exclusion criteria:

The patients with one or more of the following criteria were excluded. Patients with diabetes mellitus, peripheral neuropathy, entrapment syndrome, cancer orpregnant women. Patients who had fractures of the bones of upper extremity or previous cervical or shoulder surgery. Patients with

major neurological condition (e.g., stroke, multiple sclerosis, Epilepsy, Meningitis, and Brain tumor).

Design of study:

The study was designed as a pre- test and post-test randomized clinical trial. Patients were randomly assigned into two equal groups: Group (A) study group: Consisted of ten patients who received high power laser therapy (HPLT) for 8 minutes in addition to selected physical therapy program (hot pack, US for 5min, exercise for 20min) for eight sessions, two times weekly for four weeks. And Group (B) control group: Consisted of ten patients who received the same selected physical therapy program only (hot pack, US for 5min, exercise for 20min) for eight sessions, two times weekly for four weeks **[8]**.

Randomization:

Consented patients were randomized by sealed, opaque, identical envelopes into two groups of control and study. Each patient drew an envelope containing the group he/she was in, whether it was control or study. The number of patients in each group was (n=10). A flowchart of patients participating in the study is presented in Fig. (1).

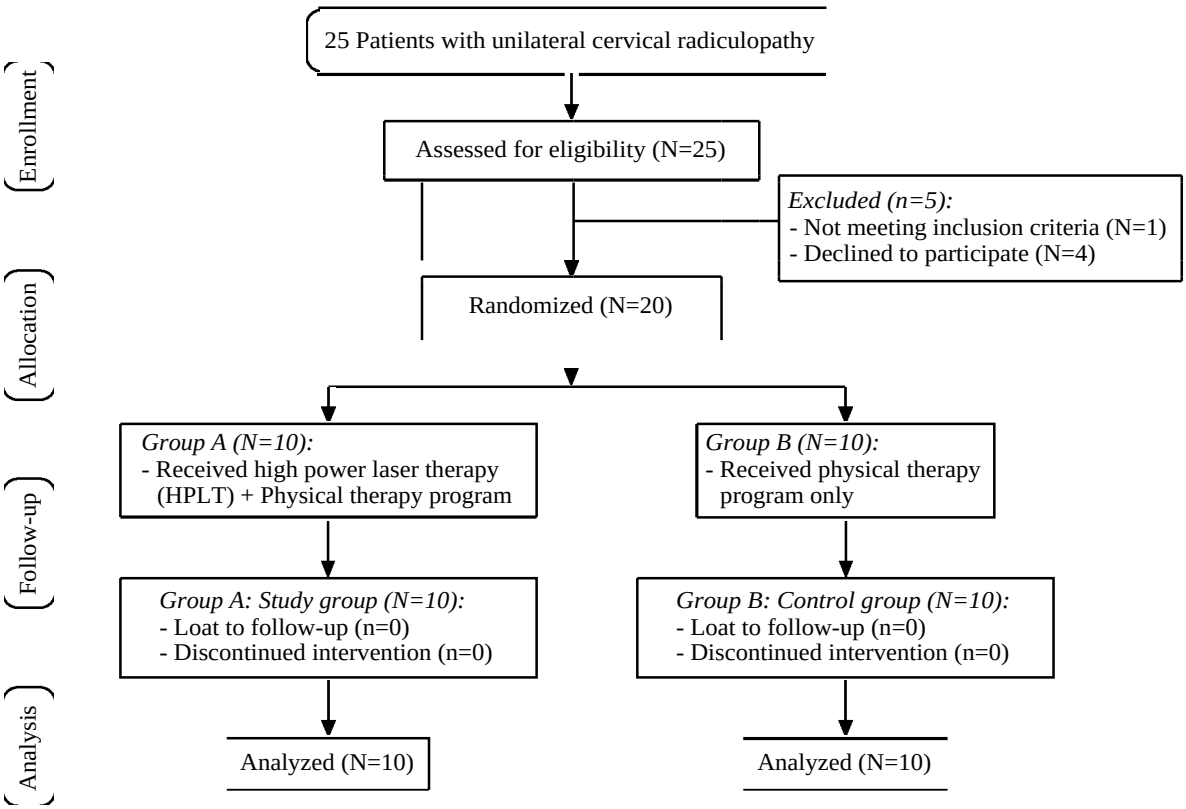

Fig. (1): Study flowchart.

Study outcome measures:

The current study included two primary outcome measures: Assessment of pain severity using Visual Analogue Scale (VAS) and Assessment of electrophysiological parameters byelectromyography (EMG)Neuropack device.

Visual Analogue Scale (VAS): This scale was used to measure the severity of pain. It is a straight line, usually 10cm long, ranging from no pain or discomfort (zero), to the worst pain (10) that the patient could feel. The patient was asked to mark a point on the line that corresponds to the current level of pain he or she experienced. This method of evaluation has been shown to be both reliable and valid for measuring pain. In many studies, it is considered the simplest to use and provides the most reliable pain severity measures **[9]**.

Standardized electrophysiological examination procedure:

Nihon Kohden Japan device was used to measure nerve conduction studies (NCS), F wave and EMG. It consists of EMG/NCS machine, Needle electrodes, Surface electrodes (active, reference, and ground), Amplifiers, Filters. Nerve conduction studies consisted of routine sensory and motor nerve conduction studies and F wave for median and ulnar nerves of the affected upper extremity. All NCS procedures were performed in accordance

with guidelines for measurement, temperature, safety precautions, and electrode placement. The amplitude, distal latency and conduction velocity were recorded. After the compound muscle action potential (CMAP) supramaximal stimulation of median and ulnar nerves at wrist was performed. The ground, stimulating and recording electrodes were placed on same sites as in the CMAPs and the F response latency was recorded. Needle electromyography (EMG) is the golden diagnostic test for radiculopathy. EMG of the following muscles was performed during rest and contraction using a bipolar needle electrode: Biceps brachii, triceps and first dorsal interosseus muscles of both upper extremities. Observations of insertional activity, normal and abnormal spontaneous activity, and motor unit firing frequency were made when recording the needle EMG. Individual MUPs were evaluated as regards amplitude, duration, and morphology (number of phases). All patients were classified according to the severity of their EMG findings into normal, mild, moderate, and severe **[4]**.

The treatment procedures: Patients were randomly assigned into two equal groups:

Group (A) study group:

Consisted of ten patients who received high power laser therapy (HPLT) with A LEVELASER EZ1 EASYONE device which used to produce a Ga Al As CW diode laser with pulsed emission 980nm and maximum average power 5W with a high level of energy penetration. While the patient was in a prone position and the head slightly bent to the front, The treatment was performed at a distance of 60-70cm, perpendicular to the cervical region, in a pulsed mode of 4 Hz, wavelength=980 nm, radiation power density P=4 W in the scan phase and 2W in the acupuncture phase and energy 840 J. Patients received pulsed HPLT laser treatment for 8 minutes. Scanning was performed transversely and longitudinally to the bilateral paraspinal muscles, inter-scapular area, upper trapezius and the neck region for 6 minutes followed by 2 minutes acupuncture. Protective goggles were used to prevent direct eye contact of the laser beam 10. The patient received also a conventional treatment inform of hot pack, US for 5min and 20min exercise (active ROM, stretching and strengthening exercise program, cervical massage and manual traction) for eight sessions two times weekly for four weeks.

Group (B) control group:

Consisted of ten patients who received the same conventional treatment only (e.g.,hot pack, US for 5min, exercise for 20min) for eight sessions two times weekly for four weeks.

Statistical analysis:

Data were analyzed using IBM SPSS software package version 20.0 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp). Qualitative data were described using number and percentage. The Shapiro-Wilk test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, standard deviation, median and interquartile range (IQR). The significance of the obtained results was judged at the 5% level. The used tests were Chi-square test; for categorical variables, to compare between different groups, Fisher's Exact or Monte Carlo correction; for Correction for chi-square when more than 20% of the cells have expected count less than 5, Student *t*-test; for normally distributed quantitative variables, to compare between two studied groups, Mann Whitney test; for abnormally distributed quantitative variables, to compare between two studied groups, Paired student *t*-test; used for comparison between related sample and Wilcoxon Rank test; used to compare two related samples, matched samples, or to conduct a paired difference test of repeated measurements on a single sample to assess whether their population mean ranks differ.

Results

Subject characteristics:

As shown in Table (1), the mean age was 42.5± 4.40 years and 45.10±5.53 years in study group and control group respectively. There was no statistically significant difference regarding age between the two studied groups ($p>0.05$). The mean disease duration in the study group was 8.80 ±6.0 months while it was 8.20±4.26 months in the control group. No statistically significant differences were observed between the two studied groups regarding disease duration ($p>0.05$).

In study group, 40% patients were males and 60% of them were females, while in control group, 20% patients were males and 80% of them were females. Non-significant difference between the two studied groups regarding gender ($p>0.05$) as shown in Table (2).

Comparison of mean values of measured variables between both groups:

No statistically significant differences were observed between the study group and control group regarding pre-treatment VAS ($p>0.05$) while

after treatment VAS showed significant decline in the study group compared to control group (p=0.01). There was significant decline in VAS after treatment compared to pre-treatment results in both study and control group (p=0.005 & p=0.017 respectively) as shown in Table (3).

Table (1): Comparison mean values of general characteristics between both groups.

Variable	Group (A) Study group Mean ± SD	Group (B) Control group Mean ± SD	Test value	p-value	Sig.
Age (years)	42.5±4.40	45.10±5.53	0.356	0.260	NS
Disease duration (Months)	8.80±6.0	8.20±4.26	0.153	0.912	NS

p-value <0.05 is significant. SD: Standard deviation.
p-value <0.01 is highly significant. t = Student t-test $p\leq0.05$ is statistically significant.

Table (2): Distribution of gender in both groups.

	Group (A) Study group (N=10)		Group (B) Control group (N=10)		Test value	p-value	Sig.
	N.	%	N.	%			
Male	4	40.0	2	20.0	X^2=0.952	0.329	NS
Female	6	60.0	8	80.0			

$p\leq0.05$ is considered statistically significant. $p\leq0.01$ is considered high statistically significant.
Comparison between groups done by Pearson Chi-Square test.

Table (3): Comparison between the two groups regarding VAS pre and post treatment.

VAS	Group (A) Study group (N=10)	Group (B) Control group (N=10)	Test value	p-value*
	Mean ± SD	Mean ± SD		
Pre-treatment	8.80±1.03	8.16±1.49	1.085	0.278
Post-treatment	4.40±1.71	6.86±1.60	2.582	0.01
Test value	2.825	2.392		
p-value#	0.005	0.017		

$p\leq0.05$ is statistically significant, $p\leq0.01$ is high statistically significant.
* Difference between two treatment groups was done by Mann-Whitney U test.
# Difference in the same treatment group Wilcoxon signed ranks test.

Ulnar nerve motor tests:

The results showed non-significant difference between the study group and control group regarding motor distal latency, motor distal and proximal amplitudes, and motor NCS of the ulnar nerve pre-treatment (p>0.05) and after treatment (p>0.05). Also, there was no significant difference in motor distal latency, motor distal and proximal amplitudes, and motor NCS of the ulnar nerve after treatment when compared to pre-treatment results in both study and control group (p>0.05) as shown in Table (4).

Median nerve motor tests:

The results revealed that non-significant difference between the study group and control group regarding motor distal latency, motor distal and proximal amplitudes, and motor NCS of the median nerve pre-treatment (p>0.05) and after treatment (p>0.05). Also, there was no significant difference in motor distal latency, motor distal and proximal amplitudes, and motor NCS of the median nerve after treatment when compared to pre-treatment results in both study and control group (p>0.05) as shown in Table (5).

Ulnar nerve sensory tests:

The results showed non-significant difference between the study group and control group regarding sensory distal latency, sensory distal and proximal amplitudes and sensory NCS of the ulnar nerve pre-treatment (p>0.05) and after treatment

(p>0.05). Also, there was no significant difference in sensory distal latency, sensory distal and proximal amplitudes and sensory NCS of the ulnar nerve after treatment when compared to pre-treatment results in both study and control group (p>0.05) as shown in Table (6).

Table (4): Comparison between the two groups regarding motor distal latency, amplitude, and nerve conduction velocity of ulnar nerve pre and post treatment.

Variables	Items	Groups (Mean ± SD)		Test value	p-value*
		Study group (N=10)	Control group (N=10)		
		Mean ± SD	Mean ± SD		
Distal latency	Pre-treatment	2.90±.27	2.97±.22	0.610	0.542
	Post-treatment	3.07±.39	3.01±.48	0.846	0.398
	Test value	1.799	0.103		
	p-value#	0.072	0.918		
Distal amplitude	Pre-treatment	9.53±2.01	9.57±1.47	0.051	0.960
	Post-treatment	10.17±2.78	8.91±1.18	1.320	0.203
	Test value	0.953	1.884		
	p-value#	0.365	0.092		
Proximal amplitude	Pre-treatment	8.94±2.19	9.19±1.28	0.312	0.759
	Post-treatment	10.07±2.46	8.27±1.19	2.084	0.052
	Test value	1.480	1.365		
	p-value#	0.173	0.205		
NCS	Pre-treatment	63.49±6.12	64.34±7.92	0.268	0.791
	Post-treatment	66.79±9.02	63.09±6.98	1.026	0.319
	Test value	1.054	0.634		
	p-value#	0.319	0.542		

p≤0.05 is statistically significant, p≤0.01 is high statistically significant
* Difference between two treatment groups was done by student t-test
# Difference in the same treatment group paired t-test.

Table (5): Comparison between the two groups regarding motor distal latency, amplitude, and nerve conduction velocity of median nerve pre and post treatment.

Variables	Items	Groups (Mean ± SD)		Test value	p-value*
		Study group (N=10)	Control group (N=10)		
		Mean ± SD	Mean ± SD		
Distal latency	Pre-treatment	4.04±0.58	4.20±0.39	0.723	0.479
	Post-treatment	4.21±0.70	4.18±0.47	0.112	0.912
	Test value	1.012	0.287		
	p-value#	0.338	0.780		
Distal amplitude	Pre-treatment	8.70±2.40	10.21±3.12	1.213	0.241
	Post-treatment	10.68±1.98	10.20±3.78	0.356	0.726
	Test value	1.027	0.015		
	p-value#	0.331	0.989		
Proximal amplitude	Pre-treatment	8.55±2.49	9.66±2.94	0.911	0.374
	Post-treatment	9.75±2.27	9.41±3.03	0.284	0.779
	Test value	1.799	0.345		
	p-value#	0.072	0.738		
NCS	Pre-treatment	59.08±4.45	58.54±5.51	0.241	0.812
	Post-treatment	59.25±6.20	58.15±4.94	0.439	0.666
	Test value	0.070	0.173		
	p-value#	0.946	0.866		

p≤0.05 is statistically significant, p≤0.01 is high statistically significant
* Difference between two treatment groups was done by student t-test
# Difference in the same treatment group paired t-test.

Table (6): Within and between groups comparison for outcome variables of Ulnar nerve sensory tests.

Variables	Items	Groups (Mean ± SD)		Test value	*p*-value*
		Study group (N=10)	Control group (N=10)		
		Mean ± SD	Mean ± SD		
Distal latency	Pre-treatment	2.85±0.38	2.87±0.38	1.453	0.146
	Post-treatment	2.99±0.69	2.85±0.51	0.848	0.396
	Test value	1.033	0.925		
	p-value#	0.302	0.355		
Distal amplitude	Pre-treatment	41.34±19.3	35.29±8.82	1.058	0.290
	Post-treatment	39.27±6.92	32.56±9.49	0.605	0.545
	Test value	0.357	0.765		
	p-value#	0.721	0.444		
NCS	Pre-treatment	46.03±5.80	45.87±6.83	1.210	0.226
	Post-treatment	46.81±9.89	46.81±7.23	0.189	0.850
	Test value	0.766	0.970		
	p-value#	0.444	0.332		

$p \leq 0.05$ is statistically significant, $p \leq 0.01$ is high statistically significant
* Difference between two treatment groups was done by student *t*-test
# Difference in the same treatment group paired *t*-test.

Median nerve sensory tests:

The results revealed that non-significant difference between the study group and control group regarding sensory distal latency, sensory distal and proximal amplitudes and sensory NCS of the median nerve pre-treatment ($p>0.05$) and after treatment ($p>0.05$). Also, there was no significant difference in sensory distal latency, sensory distal and proximal amplitudes and sensory NCS of the median nerve after treatment when compared to pre-treatment results in both study and control group ($p>0.05$) as shown in Table (7).

Table (7): Within and between groups comparison for outcome variables of Median nerve sensory tests.

Variables	Items	Groups (Mean ± SD)		Test value	*p*-value*
		Study group (N=10)	Control group (N=10)		
		Mean ± SD	Mean ± SD		
Distal latency	Pre-treatment	2.18±.34	2.41±.26	0.457	0.648
	Post-treatment	2.31±.26	2.30±.38	0.153	0.879
	Test value	0.953	0.157		
	p-value#	0.341	0.875		
Distal amplitude	Pre-treatment	33.54±9.9	40.56±15.1	0.718	0.473
	Post-treatment	32.94±12.9	36.11±12.7	1.701	0.089
	Test value	0.416	1.275		
	p-value#	0.677	0.202		
NCS	Pre-treatment	51.06±7.99	45.90±4.90	0.056	0.956
	Post-treatment	48.67±5.16	48.05±7.00	0.0	1.00
	Test value	0.308	0.293		
	p-value#	0.765	0.776		

$p \leq 0.05$ is statistically significant, $p \leq 0.01$ is high statistically significant
* Difference between two treatment groups was done by student *t*-test
# Difference in the same treatment group paired *t*-test.

F wave latency:

F wave latency of median nerve showed non-significant difference between the study group and control group pre-treatment ($p>0.05$) after treatment ($p>0.05$). There was no significant difference in F wave latency of median nerve after treatment when compared to pre-treatment results in both study and control group ($p>0.05$) as shown in Table (8).

F wave latency of ulnar nerve showed non-significant difference between the study group and control group pre-treatment ($p>0.05$) after treatment ($p>0.05$). There was no significant difference in F wave latency of ulnar nerve after treatment when compared to pre-treatment results in both study and control group ($p>0.05$) as shown in Table (8).

Table (8): Comparison between the two groups regarding F wave latency of median and ulnar nerve pre and post treatment.

Variables	Items	Groups (Mean ± SD)		Test value	p-value*
		Study group (N=10)	Control group (N=10)		
		Mean ± SD	Mean ± SD		
Median nerve	Pre-treatment	26.53±2.55	26.51±2.20	0.267	0.790
	Post-treatment	24.49±3.57	25.60±2.80	0.695	0.487
	Test value	1.716	1.872		
	p-value#	0.130	0.094		
Ulnar nerve	Pre-treatment	26.30±1.14	26.68±2.45	0.436	0.670
	Post-treatment	26.06±3.12	26.54±2.58	0.375	0.712
	Test value	0.683	0.367		
	p-value#	0.517	0.722		

$p\leq0.05$ is statistically significant, $p\leq0.01$ is high statistically significant
* Difference between two treatment groups was done by student *t*-test
\# Difference in the same treatment group paired *t*-test.

Table (9): Comparison between the two groups regarding EMG.

EMG	Group (A) Study group (N=10)				Group (B) Control group (N=10)			
	Pre-treatment		Post-treatment		Pre-treatment		Post-treatment	
	No.	%	No.	%	No.	%	No.	%
Biceps:								
Grade 2 (Moderate)	10	100	10	100	10	100	10	100
Triceps:								
Grade 2 (Moderate)	10	100	10	100	10	100	10	100
1st dorsal inter:								
Grade 2 (Moderate)	10	100	10	100	10	100	10	100

$p\leq0.05$ is considered statistically significant. $p\leq0.01$ is considered high statistically.

EMG:

Regarding EMG, all cases in both study group and control group had grade 2 (moderate) in biceps, triceps and first intercostal muscles as shown in Table (9).

Discussion

The results of the present study proved that there was a significant decline in VAS after treatment compared to pre-treatment results in both study and control group ($p=0.005$ & $p=0.017$ respectively). The study group showed a statistically significant lower values of pain intensity measured by visual analogue scale (VAS) after treatment in comparison to the control group ($p=0.010$).

This Improvement may be attributed to the analgesic effect of HPLT which based on inhibiting pain sensations at different levels. At the tissue level, histamine and bradykin in release from injured tissues is reduced, while the pain threshold increases. In addition, laser treatment decreases secretion of substance P from peripheral nociceptors which sensitize pain-transmitting neurons and development of hyperalgesia. In the peripheral nerves, laser therapy has the potential to slow transmission of pain signals inhibiting A δ- and C-fiber transmission. Moreover, laser treatments increase the secretion of endogenous opioids, like β-endorphin, which inhibit pain centrally. Laser therapy may also reduce pain indirectly by increasing microcirculation within the tissue by increasing

levels of nitric oxide, which widens the arterial and capillary vessels, stimulates electrolyte interchange in the cellular protoplasm, increases oxygen consumption, and enhances nucleic acid and protein synthesis **[10]**.

The results of the present study came in agreement with the finding of Ince et al., **[11]** whoconducted a study onninety participants with cervical radiculopathy (CR). The subjects were randomly divided into three groups: High intensity laser therapy (HILT) + exercise (n=30), placebo (PL) + exercise (n=30), and exercise only (n=30). Pain intensity in the arm and neck, neuropathic and radicular pain levels, disability, and several parameters of SF-36 showed an improvement in the short (four weeks) and medium-term (twelve weeks) in all three groups. These improvements were greater in the HILT + exercise group than in the other two groups. Which conclude that HILT in addition to exercise was much more effective in improving medium-term radicular pain, quality of life, and functionality in patients with CR. Thus, Hence HILT should be considered for the management of CR.

Another study was done by Abu Shady et al., **[12]** who studied sixty patients with CR, who were randomly divided into three equal groups; group A: Received median nerve neurodynamic mobilization, group B: Received HILT and group C: received the multimodal intervention of median nerve neurodynamic mobilization and HILT, all the groups received also conventional treatment, for 3 sessions/week for four weeks. Results showed a significant decrease in VAS andneck disability index (NDI), and a significant increase in hand grip strength and cervical range of motion (CROM) in HPLT group B and group C more than group A, while group C showed the most significant improvement ($p<0.0001$).

In agreement with the current study, Venosa et al., **[13]** in a study comparing the effect of HILT and combination of ultrasound (US) treatment and transcutaneous nerve stimulation (TENS) in patients with cervical spondylosis found that in the two groups, cervical ROM, VAS, and functional scores showed significant changes. Both HILT plus exercise and US/TENS plus exercise effectively increased cervical ROM and reduced pain (with a significant greater decrease in group HILT plus exercise group). Both therapeutic modalities demonstrated analgesic efficacy and improved function in patients affected by cervical spondylosis four weeks after the therapy. And they concluded that HILT plus exercise was more effective than US/TENS plus exercise. Thus, HILT can be promoted and used in this pathology with positive outcomes.

Furthermore, the study of Hal´adaj et al., **[14]** on 174 patients with cervical spondylosis who were divided into two randomized groups. In group I (88 subjects) traction therapy with the Saunders device was applied, and in group II (86 subjects) HILT was applied. The measurement of the range of cervical spine movement, VAS, and the neck disability index (NDI) questionnaire were used. They found that theresults obtained by the Saunders and HILT methods were similar immediately after the therapy and after 4 weeks (the medium-term follow-up). However, in long-term follow-up, there was a significant increase in the maintenance of positive therapeutic effects with the HILT method, andthey concluded that HILT was more effective than the Saunders method in long-term follow-up.

In contrast Yilmaz et al., **[15]** compared the effect of high-intensity laser therapy (HILT) and a combination of transcutaneous nerve stimulation (TENS) and ultrasound (US) treatment on pain, range of motion (ROM) and functional activity on cervical pain associated with cervical disc herniation (CDH). Their results revealed that there was a significant improvement incervical ROM, VAS and neck pain and disability scale (NPADS) in both groups ($p<0.05$). But no statistical significance was found between the two groups ($p>0.05$) when the groups were compared in terms of post treatment VAS, NPADS and ROM values.

Another study by, Huang and Gao **[16]** aimed to assess the safety and efficiency of ultrasound and high-intensity laser therapy (HILT) in the lumbar disc herniation (LDH) patients and concluded that the HILT is as effective as the ultrasound therapy in treating pain for LDH.

The results of the present study are supported by Boyraz et al., **[17]** evaluated the efficiency of high intensity laser and ultrasound therapy in patients with lumbar disc herniation. Patients were randomly divided into three groups: Group 1 received 10 sessions of high intensity laser to the lumbar region, Group 2 received 10 sessions of ultrasound, and Group 3 received medical therapy for 10 days and isometric lumbar exercises. The efficacy of the treatment modalities was compared with the assessment of the patients before the therapy, at the end of the therapy, and in third month after the therapy. They found significant difference in VAS score in third month of the therapy between Groups 2 and 3. However, the

evaluation of the patients after ten days of treatment didn't show significant differences between the groups compared to baseline values. They concluded that HILT, ultrasound, and exercise were efficient therapies for lumbar discopathy, but HILT and ultrasound had longer effect on some parameters.

In contradiction, Kolu et al., **[18]** compared the effects of HILT and a combination of TENS with US therapy on pain and functionality in patients with chronic lumbar radiculopathy. Results showed thatin both the HILT group and the TENS+US group, VAS (low back with unilateral leg pain) and Oswestry stability index (ODI) scores showed significant changes. At the end of the two weeks intervention, participants in the TENS+US group showed a significantly greater decrease in pain than participants in the HILT group. Statistically significant differences in pain variation and functionality (VAS and ODI) were observed four weeks after treatment sessions for participants in the TENS+US therapy group compared with participants in the HILT group, and they reported that TENS combined with US combined with exercises were more effective than HILT combined with exercise.

In line with the contradicting study mentioned above, the author Taradaj et al., **[19]** agreed that theuse of high- and low-energy laser therapy methods are ineffective in relation to patients with lumbar disc degenerative changes in both the short- and long-term perspectives and do not show a significant advantage over the placebo effect in patients with lumbar disc degenerative changes.This contradiction may be due to using different parameters of the HPLT in theirstudy which may affect the penetration of the laser beam inside the body thus affects the analgesic effect of the HPLT.

In the current study, there was no significant difference in the motor distal latency, distal motor amplitude, proximal motor amplitude, motor NCS, sensory distal latency, sensory distal amplitude and sensory NCS of both median and ulnar nerves after treatment when compared to pre-treatment results in both study and control group ($p>0.05$).

Also, the results of F wave latency of both median and ulnar nerves and EMG of biceps, triceps and first intercostal muscles showed that, there was no significant difference after treatment when compared to pre-treatment results in both study and control group ($p>0.05$). Which may be attributed to small sample size or short follow-up period of the treatment.

This finding agreed with Hojjati et al., **[20]** who study the effect of high-power and low-power lasers on pain, function, pinch strength and nerve conduction study in patients with carpal tunnel syndrome (CTS) and revealed that, however laser therapy showed significantly better results compared to a wrist splint, Nerve conduction evaluation findings did not reveal any significant difference.

Another study by Ezzati et al., **[21]** compared the dose dependent effects of LLLT and HILT on pain and electrophysiology studies in patients with CTS, and revealed that there was significant decrease in VAS ($p<0.001$), the latency of CMAP ($p=0.001$) and improvement in compound muscle action potential (CMAP) amplitude ($p=0.02$). But there wasn't a significant different for the CMAP conduction velocity, sensory nerve latency and amplitude ($p>0.05$).

Unlike the present study, a study by Abdelmageed et al., **[22]** who investigated the influence of high power laser therapy on pain, degree of straight leg raise, six meters walk test and electrophysiological studies in patients with chronic discogenic sciatica. Clinical and electrophysiological studies (Hoffmann reflex) were used for assessment and their findings revealed that there was significant decrease in pain intensity and latency of Hoffmann reflex (H-reflex) in both groups. There was a significant decrease in VAS and H reflex latency of study group compared with that of control group post treatment ($p<0.01$). Thus, concluded that suggested high power laser therapy is an effective method in treatment of patients with chronic discogenic sciatica.

Furthermore, the study by Casale et al., **[23]** compared High-intensity laser versus TENS in reducing pain and paresthesia; and in improving motor and sensory median nerve conduction parameters in patients with carpal tunnel syndrome (CTS) and revealed that high-intensity laser is better than TENS in improving both pain and paresthesia as well as neurophysiological parameters in CTS.

Conclusion:

It can be concluded that HPLT is an effective noninvasive physical therapy modality in reducing pain in patients with cervical radiculopathy. However, The HPLT has no significant effect on the findings of electrophysiological parameters.

Limitation:

Small number of patients and the lack of evaluation of long-term results.

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تأثير العلاج بالليزر عالى الطاقة على الألم والتشخيص الكهربائى فى مرضى إعتلال جذور الأعصاب العنقية

اعتلال الجذور العنقية وحالة إعاقة لها تأثير سلبى كبير على الصحة العقلية والأداء البدنى والمشاركة الإجتماعية ولذلك فإن الهدف من الدراسة هو تحديد تأثير العلاج بالليزر عالى الطاقة على الألم ودراسة الفسيولوجيا الكهربية فى مرضى اعتلال الجذور العنقى حيث تم إجراء البحث على عشرين مريض من الذين يعانون من اعتلال الجذور العنقى تتراوح أعمارهم بين (٣٠-٥٠) عاماً وتم تقسيمهم بشكل عشوائى إلى مجموعتين متساويتين. تتألف المجموعة أ (مجموعة الدراسة) من عشرة مرضى تلقوا علاج اباالليزر عالى الطاقة لمدة ثمانى د قائق بالإضافة إلى بر نا مج العلاج الطبيعى المختار، المجموعة ب (مجموعة ضابطة) يتألف من عشرة مرضى تلقوا نفس برنا مج العلاج الطبيعى المختار لثمانى جلسات فقط. حضر جميع المرضى عيادة العلاج الطبيعى مرتين أسبوعياً لمدة أربعة أسابيع. تم التقييم بواسطة مقياس الالم البصرى قبل العلاج وبعده بالإضافة إلى اختبارات التوصيل العصبى وتخطيط كهربية العضل بموجة F ورسم العضلات بالإبرة. وقد أظهرت النتائج وجود انخفاض ذو دلالة إحصائية فى درجة الألم بعد العلاج مقارنة بنتائج ما قبل العلاج فى كل من مجموعة الدراسة والمجموعة الضابطة. أظهرت مجموعة الدراسة قيماً منخفضة ذات دلالة إحصائية لدرجة الألم بعد العلاج مقارنة بالمجموعة الضابطة. ومع ذلك، لم تكن هناك تغييرات كبيرة فى و قت الإستجابة الحركى البعيد، والسعة الحركية البعيدة، والسعة الحركية القريبة، سرعة التوصيل العصبى الحركى، وقت الإستجابة البعيد الحسى، والسعة البعيدة الحسية، وسرعة التوصيل العصبى الحسى لكل من الأعصاب المتوسطة والزندية بعد العلاج عند مقارنتها بنتائج ما قبل العلاج فى كلا من مجموعة الدراسة المجموعة الضابطة. كما أظهرت نتائج وقت إستجابة الموجة F لكل من الأعصاب المتوسطة والزندية ومخطط كهربية العضل للعضلة ذات الرأسين والعضلة ثلاثية الرؤوس والعضلات الوربية الأولى أنه لا يوجد فرق كبير بعد العلاج مقارنة بنتائج ما قبل العلاج فى كل من مجموعة الدراسة والمجموعة الضابطة. وبذلك يمكن الاستنتاج أن الليزر عالى الطاقة هى طريقة علاج طبيعى غير جراحية فعا لة فى تقليل الألم فى المرضى الذين يعانون من اعتلال الجذور العنقى، على الرغم من أن الليزر عالى الطا قة ليس له تأثير ملحوظ على نتائج دراسات الفسيولوجيا الكهربية.