Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 355 - 362
Received 16 February 2021; Accepted 08 March 2021.

Effect of Low Level Laser Therapy on Nerve Conduction Velocity in Diabetic Neuropathic Patients: A Randomized Controlled Trial

Amany Gomaa Atiaa[1*], Osama Fekry Al Balah[2], Khaled A Hameed Mostafa[3],Dina Nabil Abas[4], HebaHazaa Abd El Wahab[5]

[1*]Assistant Lecturer, Faculty of Physical Therapy, Sinai University,Egypt.E-mail: dr.mony_555@yahoo.com

[2]Professor of Zoology andPhotobiology,Biomedical Application of Laser, NILES, Cairo University, Egypt.

[3]Professor and Head of Pain Relief Unit NCI, Cairo University, Egypt.

[4]Professor of Pain Relief Unit NCI, Cairo University, Egypt.

[5]Lecturer, Pediatric Department, Faculty of Physical Therapy, Cairo University, Egypt.

ABSTRACT

Background: Treatment of neuropathic pain is characterized by poor response and frequent side effects to drugs that are commonly used. Theaim of this study was to evaluate the efficacy of adding low-level laser therapy [LLLT] to traditional medication versus traditional medication only on pain level and nerve conduction velocity (NCV) indiabetic peripheral neuropathic patients (DPN).

Materials and Methods: Thirty patients suffering from DPN were included and randomly divided into two equal groups: group A (received LLLT in addition to the traditional medication) and group B (control group that treated by traditional medication only). Peripheral pain by Visual analog scale (VAS) and NCV of peroneal nerve by Electromyography were assisted pre-treatment and eight weeks post treatment.

Result:A significant reduction of VAS and significant increase of NCV of peroneal nerve were reported at post treatment measurements in compared to pre-treatment for group A only.As well as,A significant reduction of mean values of VAS and significant increase of mean values of NCV were reported at group A post treatment measurements when was compared with group B.

Conclusion: This stud indicates that LLLT is a valuable therapeutic modality that can be usedto decrease the pain and improve the NCV inpatients with painful DPN.

KEYWORDS

DiabeticPeripheral Neuropathy, Nerve Conduction Velocity, Low-level Laser Therapy.

Introduction

One of the most common complicationsthat affecting about 59%- 66% of diabetes patients is diabetic peripheral neuropathy (DPN)[1]. In type 2 diabetes more than 25% of patients have neuropathic pain that usually attacking the lower extremities. Disturbed sleep and diminished quality of life occurs as results of this pain [2]. Neuropathic pain is the result of damage to one or more of any part of the nervous system that includes central nervous system, spinal cord andnerves. Patients with DPN suffer from different forms of pain as spontaneous pain, allodynia and hyperalgesia [3]. Additionally, theyfrequently described the pain as deep-seated ache, but

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some time they described it as superimposed lancination, or burning thermal quality [4].

Moreover, chronic inflammatory demyelinating polyradiculopathy progressed in diabetic patients [5].Nerve conduction velocity studies (NCV) represent objective, sensitive and reliable techniques for neuropathy detection and follow up. Yet its availability may be limited and it may be difficult to be used in routine follow-up [6]. Glycemic control, patient education and exercise are the first line of DPN treatment.Additionally, symptomatic therapy by administering drugs like antidepressants, anticonvulsants and opioids is a standard therapy[7]. Many of these treatments remain not good enough as a number of patients do not tolerate theirside effects[8].

Among the different options for treatment, Low Level Laser Therapy (LLLT) is a talented therapy thatused for controllingthe pain in DPN. It triggers the biochemical changes within human cells [7]. Biostimulation or photobiomodulation is the mechanism in which LLLT bring a photochemical response in the cell [9]. There are several other mechanisms such asspeeding up the rate of redox reaction throughincreasing the oxygen consumption, increasing collagen synthesis and reducing oxidative stress. Additionally, LLLT may control the pain by increasing adenosine triphosphate synthesis and increasing the production of anti-inflammatory cytokines [10, 11].Thereforetheaim of this study was to evaluate the efficacy of adding LLLT to traditional medication versus traditional medication only on pain and NCV in diabetic neuropathic patients.

Materials and Methods

Study Design

This study was designed as a randomized controlled trial. That had aprospective, single-blind and pre–post-test characters.The researcher obtained the ethical approval before study commencement from the institutional review board at The National Institute of Laser Enhanced Sciences, Cairo University. The study was conducted between December 2018 and October 2020.

Participants

Thirty patients with DPN were included in the study. There ages ranged from 40 to 55 years old. All patients have type 2 DM with symptoms and signs of mild DPN and the duration of illness was more than 5 years [12]. Patients were excluded if they had peripheral vascular disorders as varicose veins or deep venous thrombosis or if they had any medical, psychiatric, or neurological disorders that could interfere with study. Additionally, if they have any metallic implants at the area of treatment or if they have broken or infected skin at the area of treatment. They were recruited from diabetic clinic at Zagazig University Hospital.

Randomization

The researcher explained the benefits and purpose of the study and tolled patients of their ability to withdraw or refuse at any time. Then written informed consents were obtained from patient or patient care giver. Patients were randomly assigned into two equal groups (group A and groupB).Group A: 15 patients who treated by LLLT in addition to traditional medication.Group B (control group): 15 patients who received traditional medication only. Computer generated

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randomization cards that were present in sealed envelopes were opened by aself-governing, blinded research assistant.

Interventions

Low-level Laser Therapy (LLLT)

Patients in group A treated by LLLT three times per week. The Infrared laser (Pagani, I.R, LASER 905 nm, Italy) equipment was used (905 nm wavelength, 27 mW average power, LASER probe 0.5 mm diameter and energy of 4J/point). The points of application were dorsum of foot,head of fibula andlateral calf muscle. Each point was treated for 60s, and the laser head was applied perpendicularly on each point.

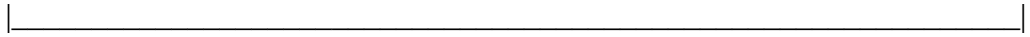
Traditional Medication

Patients in group B received medical treatment only which was described by physician according to pain severity.

Outcome Measures

Visual Analog Scale (VAS)

This valid scale was used to determine pain severity by using 0 to 10 ascending scale VAS (0= no pain, 10= unbearable pain). A horizontal line (10 cm) was drawn with word anchors at each side such as "no pain" at one side and "unbearable pain" on the other side of the scale (Figure 1). The patient represents pain intensity by marking the point that represents the pain severity along the line. A number was obtained by measuring in millimeters up to the point the patient was indicated. Same physical therapists conducted the measurement two times; pre-treatment and eight weeks post treatment.



No painunbearable pain

Fig. 1. Shows visual analog scale (VAS).

Nerve Conduction Velocity (NCV)

EMG was performed in all patients involved in this study. Nerve conduction was studied using (Neuropack, Japan) electromyography (EMG).To measure the peroneal nerve motor responses, the researcher applystimulation at the neck of fibula and the recording was obtained from extensor digitorum brevis muscle. Same physical therapists conducted measurements pre-treatment and eight weeks post treatment.

Statistical Analyses

Mean ± standard deviationwere used to express the results. Unpaired t-testwas used to compare between groups regarding the mean values of variables (control and study). While pair-wise comparison (pre-treatment versus post-treatment) within the same group was performed using paired t-test. Data analysiswas carried out by Statistical Package for Social Sciences (SPSS)

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computer program (version 19 windows). P-value < 0.01 was considered highly significant and ≤ 0.05 was considered significant.

Result

Thirty patients with type 2 diabetes, of both genders, were randomly distributed into two equal groups. First group (A) included 15 patients with type 2 diabetes who treated with LLLT in addition to traditional medication for 8 weeks. Second group (B) included 15 type 2 diabetic patients who treated withtraditional medication only for 8 weeks. All participants completed the study evaluations and treatments as shown in Figure 1. At baseline, both groups were similar (p > 0.05) regarding age, weight, height, BMI, and all outcome measures (Tables 1–2).

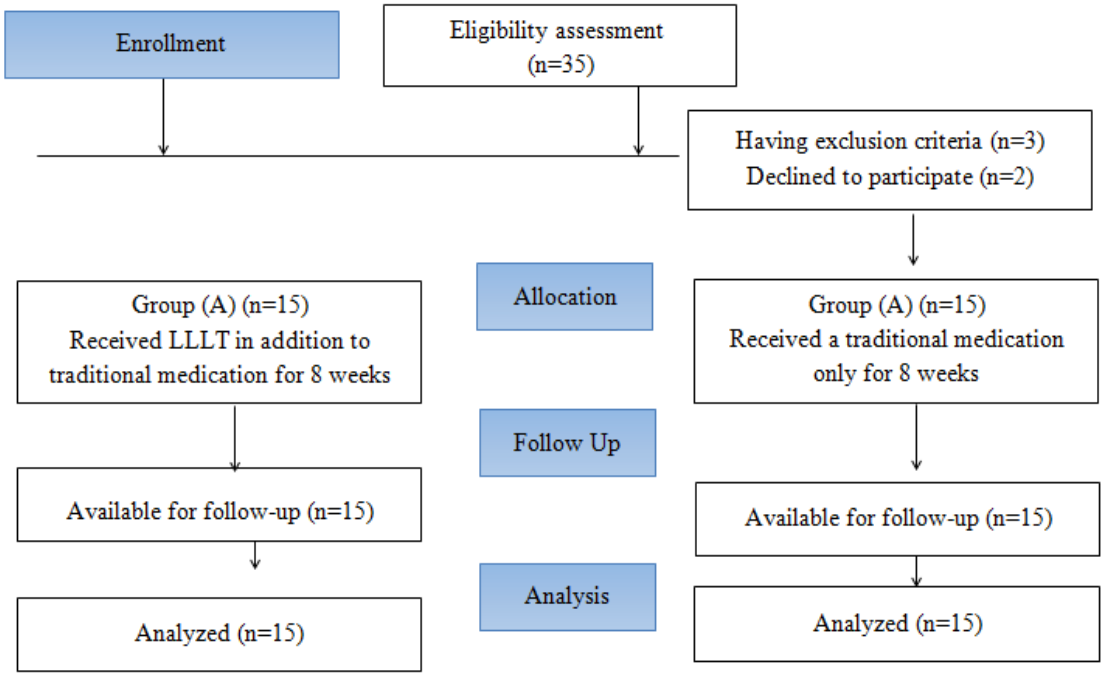

Fig. 2. Flow chart of the study

Table 1. Baseline characteristics of participants in both groups

	Group (A) (n = 15)	**Group (B) (n = 15)**	**P value**
Age (yrs.)	46.17±3.17	44.83±3.26	0.687^{NS}
Weight (Kg)	77.57±12.80	76.57±10.76	0.748 ^{NS}
Height (Cm)	172.47±7.55	171.27±7.41	0.933 ^{NS}
BMI (Kg/m^2)	25.64 ±2.80	26.35±5.13	0.457 ^{NS}
^{NS} P > 0.05 = non-significant, P = Probability.			

The dependent variables mean ± SD values in the "pre" and "post" tests for both groups are illustrated in table (2). "Paired t test" appeared that the post treatment values of VAS were significantlydecreased (p<0.05), while the post treatment values of NCV of peroneal nerve were significantly increase (p<0.05) in compared to pre-treatment values for group A only.

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Regardingbetween groups effect on all dependent variables, "unpaired t test" revealed that there was no significant differences ($p>0.05$) in the mean values of the "pre" test between both groups.Additionally, there was significant reduction ($p<0.05$) of mean values of VAS and significant increase ($p<0.05$) of mean values of NCV of peroneal nerve at group A compared to group B in "post" test measurements.

Table2. Descriptive and Inferential Statistics of the Dependent Variables in the Experimental and Control Groups Pre and Post the Eight-Week Study Period

		Group (A) (n=15)	**Group (B) (n=15)**	**t-value**	**P value***
VAS	Pre training	8 ± 1.00	7.6 ± 1.67	0.459	0.659^{NS}
	Post training	2.8 ± 0.83	7.6 ± 1.7	-5.737	0.0001^{S}
	t- value	13.898	0.001		
	P value**	0.001^{S}	0.99^{NS}		
NCV	Pre training	98.8 ± 45.35	45.02 ± 12.94	2.55	0.055^{NS}
	Post training	115.1 ± 50.33	45.02 ± 12.94	3.015	0.017^{S}
	t- value	-4.319	0.001		
	P value**	0.012^{S}	0.99^{NS}		

* Inter-group comparison; ** intra-group comparison of the results pre and post training.
^{NS} P > 0.05 = non-significant, ^{S} P < 0.05 = significant, P = Probability; NCV: Nerve Conduction Velocity.

Discussion

One of the most important diabetic complications is neuropathy. In spite of various treatment modalities, no significant approach seems to be the standard [13]. Therefore, this study was conducted to investigate the efficacy of adding LLLT to traditional medication versus traditional medication only on pain and NCV in diabetic neuropathic patients.

This study revealed that there was a significant reduction of post treatment VAS and a significant increase of post treatment NCV of peroneal nerve when compared with pre-treatment for group A only. These results were in agreement with Anju et al, [7] who conducted a systemic review and concluded that,LLLT control diabetic neuropathic pain. This systematic review aimed toevaluate the effectiveness of LLLT on controlling of diabetic neuropathic pain. In this review 6 studies were included,and the measurement outcomes werepain level, NCV and quality of life.This review showed that LLLT is a good modality that was used in treatment of patients with diabetic neuropathy [7].

Additionally, Elgendy et al, [14] randomly divided 40 patients with carpal tunnel syndrome into two groups. Group one;treated with active LLLT.Group two;treated with placebo LLLT. There was a significant reduction in VAS and motor velocities of median nerve and significant improvement in functional first group when compared with second group. This study concluded that the LLLT is safe and effectivemodality in pain and inflammation reduction and in improvement of electro-neurophysiological characteristics of median nerve in patients with carpal tunnel syndrome [14]. Many other studies agree with our result about the positive effect of LLLT

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in reducing pain [15-17] and increasing the NCV[18].

In regard to between groups comparison the results of this study revealed that there was post treatment significant reduction of VASmean values and significant increase of peronealNCV mean values at group A compared to group B. These positive effects of LLLT were explained by many literatures that illustrated many mechanisms of LILT action. The analgesic effect of LLLT may be due to neuron metabolism activation,increase of pain threshold and increase endorphin release.MoreoverLLLT has an anti-inflammatory effect through microcirculationactivation, change the level of prostaglandin, normalization of osmotic pressure and elimination of edema. This anti-inflammatory effect leads to subsequent pain control.Additionally, the reflexogenic effect of LLLT associated with nerve endings irritation followed by nerve centers excitation which leads to stimulation of physiological function [19].

Conclusion

The findings of this studypoint tothe effective role of LLLT in controlling the pain and improving the NCV inpainful diabetic neuropathic patients.

Financial Support

This study received no financial support.

Acknowledgement

Researchers would like to thank all the participants for the sharing in this study.

Conflict of Interest

There is no conflict of interest to be pronounced by the authors.

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Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 3, 2021, Pages. 355 - 362
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