

Effect of Monochromatic Infrared Energy Light Versus Low Level Laser Therapy on Diabetic Foot Neuropathy

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Abstract

Background Diabetic neuropathy is long-term complication of diabetes, can affect almost half of the diabetic population, and is associated with higher morbidity and mortality. There is no optimal intervention universally accepted by clinicians. Monochromatic infrared photo energy (MIPE) and Low Level Laser Therapy (LLLT) are a relatively new light modality used to improve nerve conduction velocity, reduce pain and increase circulation. **Purpose:** This study was conducted to compare MIRE versus LLLT on nerve conduction velocity, pain and functional activity of daily living in patients with diabetic foot neuropathy (DFN). **Material and Methods:** Thirty patients with peripheral neuropathy type 2 diabetes and suffering from neuropathic pain especially in lower limbs, main age (56.29 ± 2.98) years, all patients have diabetes for more than 10 to 15 years. They were divided into two equal groups: Group (A) consisted of 15 patients received MIRE for 40 minutes to each limbs. Group (B) consisted of 15 patients received LLLT for 20 minutes to each limb. All patients who participated in the study had been subjected to various physical assessment procedures including: Nerve conduction velocity, Pain intensity and Quality of Life that all measured before and after four weeks of treatment. **Results:** Statistically there was statistical significant improvements in nerve conduction velocity, pain intensity and functional activity ($P < 0.05$) in both group. However, there was no significant statistical difference between both groups ($P > 0.05$). **Conclusion:** both monochromatic infrared energy and low level laser therapy were effective in improvement of neuronal activity to deep peroneal nerve, decrease pain intensity and improve functional activity of daily living in patients with diabetic neuropathy.

Keywords: Diabetic neuropathy, Low level laser Therapy, Monochromatic infrared energy, Nerve conduction velocity.

Introduction

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both.[1]. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels [2].

Diabetic Peripheral Neuropathy (DPN) is considered one of the most common long-term microvascular complications of diabetes mellitus, affecting up to 50% of people with diabetes it is thought to be progressive and irreversible [3]. DPN represents a huge economic burden to the health care system and is prevalent worldwide [4]. All nerve fibers may be injured but small myelinated and unmyelinated fibers that conduct pain and temperature are most affected, repairing mechanisms of nerve regeneration are also affected [5]. It is a late finding in type 1 diabetes but can be an early finding in type 2 diabetes [4].The onset of DPN is may be genetic or acquired, progress quickly or slowly, involve motor, sensory, and/or autonomic nerves[5]. Diabetes peripheral neuropathy result in discomfort, pain, numbness in lower extremity, primarily the soles and toes and some time in hand and arm. In addition to discomfort, all areas of patients' life including sleep, mood, mobility, ability to work, interpersonal relationships, overall self-worth, and independence, are affected. Also there are disturbance in balance, foot ulceration, infection

and amputation [6]. Long-standing peripheral neuropathic pain associated with peripheral neuropathy occurs in one of six diabetic subjects. Chronic painful diabetic peripheral neuropathy can cause symptoms that last for years and severely impair functional activities, and consequently the quality of life and high consumption of health care resources [7].

The most effective approach to preventing DPN and its complications consists in strict control of diabetes [8].Once developed, few specific interventions are available for treatment [9] Current therapy for DPN is purely symptomatic, aiming to relieve the pain through the administration of various analgesic drugs, but these drugs are frequently associated with various side effects and do not slow the progression of the underlying neuropathy [10]. Non-pharmacological symptomatic treatments have also been proposed, including acupuncture [11] static and pulsed magnetic field therapies [12], and various electrotherapies, including transcutaneous electrical nerve stimulation (TENS) [13], percutaneous electrical nerve stimulation, The efficacy of most conservative treatment options for painful diabetic neuropathy is still little known, and the management of neuropathic pain is limited due to adverse effects [14].

Monochromatic infrared photo energy (MIRE) and Low Level Laser Therapy (LLTT) are relatively new forms of light energy used to manage DPN. The monochromatic photo energy delivers MIPE with a wavelength of 890

nm. The monochromatic light is emitted by an array of gallium aluminum arsenide diodes that are placed in the target skin. The diode array must be placed in direct contact with the target skin, as the monochromatic infrared photo energy energizes cells in the epidermis and the most superficial portion of the dermis, thereby warming the skin [15]. The benefits of the MIPE rely on skin contact, pulsation, wavelength, radiant power, and energy density. MIRE is approved by the Food and Drug Administration as a complimentary strategy to improve blood perfusion and reduce pain [15]. The mechanisms by which MIRE produces its biological effects by penetrate to a greater depth than visible light [15]. It is suggested that photo stimulation of hemoglobin increases nitric oxide release, leading to blood flow improvement [16]. Other biological effects of MIRE may be the enhancement of cell metabolism, by stimulating mitochondrial ATP production, accelerating antioxidant mechanisms, and improving cell function [17].

Low Level Laser Therapy (LLLT) is another form of light energy used in managing DPN. LLLT is the use of therapeutic (or cold) laser (non-invasive) light delivered in the therapeutic window by monochromatic laser light emission from the laser device (diode) in wavelengths ranging from 600 to 950 nm [18], Light particles at dosages, usually less than 35 J/cm, known as photons penetrate up to 0.5 cm into tissue to provide relief from pain, eliminate inflammation (swelling) or to repair damaged tissues, improve micro circulation, useful for treatment of cutaneous ulcers, diabetic

neuropathy, chronic pain, lymph edema, musculoskeletal and soft tissue injuries [19]. The mechanism of action of laser therapy is associated with the ability of the cell to absorb the photon and transform the energy into adenosine triphosphate (ATP) by forming singlet oxygen, reactive oxygen species, or nitric oxide, all of which influence the normal formation of ATP [20]. The aim of the present study was to compare the differences between the effect of monochromatic infrared energy versus the effect of low Intensity laser therapy on NCV, pain and ADL in patients with diabetic foot neuropathy.

Design of Study

Pretest-posttest experimental design.

Subjects, Instrumentations and Methods

Subjects:

Thirty patients [13 (43%) males and 17 (57%) females] with type 2 diabetes suffering from neuropathy especially in lower limbs participated in this study. Their glucose level ranged between 130-350 mg/l and take oral hypoglycemic. Patient's ages ranged from 50 to 65 years with a mean of (56.29 ± 2.98) years. Clinically, all patients were suffered from glove and stock numbness hypoesthesia, burning sensation, spasm of foot muscles and muscle weakness of lower limbs. Patients have diabetes for more than 10 to 15 years (long standing diabetes). With Exclusive Criteria included the following: Patients with severe intolerable pain, neuropathy not due to diabetes, Patients with musculoskeletal deformities, Patients with severe

cognitive dysfunction , Patients with other neurologic problems as hemiplegia Unstable cardiac disease, high blood pressure, Insulin dependent diabetic patients were also excluded. The study procedures were explained and informed consent was obtained from eligible participants. Patients were recruited from faculty of physical therapy and the Coptic hospital. They were assigned randomly into two equal groups: Group A Fifteen patients (n=15) received MIRE for lower extremities for 40 min., Group B Fifteen patients (n=15) received LLLT for lower extremities for 20 min .The tester made group comparisons at the initial visit (before initiation of treatment) and after 4 weeks. The duration of intervention was 4 weeks per participant, and each participant was scheduled to undergo 3 sessions per week .i.e 12 sessions

Instrumentation

A) Assessment instruments

1. Nerve Conduction Studies (NCS)

Neuro pack plus version 1.59, NHON KOHDEN, had four channel electrodes diagnosis system and built amplifier was used to measure nerve conduction velocity for deep peroneal nerve [21].

2. Visual analog scale

VAS was used to assess the intensity of perceived pain. The VAS is a reliable and valid tool for the quantification of perceived pain [22].

3. Quality Life Scale (QLS)

This scale was used to assess the effect of diabetic neuropathy in patient with DM type 2 on their quality of life. The authors of D -39intended it to have 'range and reliability', in other words, to be highly relevant to a wide range of diabetic patient over time , easy to use and understand , and to possess good psychometric properties .A slightly modified version has been developed for use in clinical trials[23] The D-39 comprises 39 items in five domains, namely energy and mobility (15 items), diabetic control (12 items) , anxiety and worry (4 items) , social and peer burden (5 items) , and sexual functioning (3 items) . Scores are marked on seven _point visual analogue scales ranging from 'not affected at all' to 'extremely affected'.

B) Therapeutic Instruments

1. Monochromatic Infrared Energy (MIRE)

The MIPE intervention was administered using the Anodyne® Therapy System, model 120 (Anodyne Therapy, LLC, Tampa, FL). The device consists of a base power unit and 4 therapy pads, each containing 60 super luminous infrared diodes emitting pulsed near-infrared irradiation at 292 times/ second Hz with a wavelength of 890 nm through the diodes. The active unit provides 62.4 Joules/cm² of energy density. The pads can be placed on the skin and the infrared energy is delivered in a homogeneous manner in a session lasting from 30-45 minutes. The area of Anodyne LEDs per therapy pads is 22.5 cm², yielding a total treatment area of 180 cm² [15].

2. Low Level Laser Therapy (LLLT)

The Laser Scanner device (Italy ASA Co., Bravo Style), which emits both He-Ne and infrared laser in a mixed light. He-Ne wave length was 850 nm, continuous. Infra-red wave length was from 780-905 nm, pulsed this device discharges a uniform irradiation of the relatively large areas in a carefully controlled and prescribed manner. Infrared Laser applied on both feet for twenty minutes using frequency of 150 Hz wave length of 905 nm and an average power of 0-60w, with energy density of 3.6 joules/cm². The output of the device was calibrated at each frequency with a power meter (Omega Laser Systems), and an I.R. Laser Detection Card [18].

Procedure

A) Assessment procedure

1. Nerve Conduction Velocity for deep peroneal nerve

Each patient was placed in a comfortable, relaxed supine lying position, while hip and knee were slightly flexed with the ankle in a neutral position.

Peroneal nerve CV was measured with standard surface electrodes. Active (recording) electrode was positioned over the anterior lateral aspect of the proximal mid tarsal area of the foot (the anatomic center of the extensor digitorumbrevis muscle). Reference electrode was positioned on the extensor digitorumbrevis muscle on the little toe and ground electrode was positioned on the lateral or medial

malleolus between the active and stimulating electrodes [25]. Stimulation was applied distally about 8 cm proximal to the active pickup electrode, just lateral to the tibialis anterior tendon while proximal stimulation was applied just below the head of the fibula, with the recording electrode over the extensor digitorumbrevis and the earth electrode was positioned mid-calf [26].

2. Pain intensity

Using VAS, the patient was given a 10-cm line and asked to draw on the line the intensity of pain he was feeling. The left end of the line represented "no pain at all," and the right end of the line represented the "worst pain you can imagine." The patient's mark on the line was measured (in centimeter) with a ruler [22].

3. Quality Life Scale (QLS)

Each patient was asked to place an "X" on the line to show whether that factor affects his quality of life "extremely," "not at all," or some place in the middle [27].

B) Treatment procedure

1. Monochromatic Infrared Energy (MIRE)

It was applied for patients of group A. Each patient was placed in a comfortable position such as long sitting or supine lying position on the bed, the places on which the electrode were applied should be cleaned, the electrode pads were wrapped with a clear plastic wrapping to prevent contamination, the pads were placed with direct contact with 4 pads, 2 for each foot one was on forefoot and the

other was on heel, the duration of each session 40 minutes [28].



Fig. (1): Application of MIRE therapy

2. Low Level Laser Therapy (LLLT)

It was applied for patients of group B. Each Patient was placed in supine lying, fully relaxed and supported position. The area of laser application on the leg and foot was washed by alcohol. The laser scanner was applied perpendicular on the area of laser application. The laser beam adjusted to cover the area of application in width and length from the malleoli till tip of the big toes. The delivery of laser radiation continues for 20 min. The energy was adjusted at 10 joules/cm and the frequency was 2600 Hz [29].



Fig. (2): Application of LLLT

Statistical analysis

The characteristics of the studied group were summarized using descriptive statistics. Quantitative data are reported as means and standard deviations (mean \pm SD). The mean values of the nerve conduction velocity, pain intensity and functional activity of daily living before and after 4 weeks of treatment in each group were compared using (Pairwise) t-test, Statistical analysis was conducted using SPSS for windows, version 20 (SPSS, Inc., Chicago, IL).inferential statistics in the form of 2 \times 2 mixed design MANOVA to differentiate between two groups. The level of significance for all tests was 0.05.

RESULTS

As indicated by the independent t test, there were no significant differences ($p > 0.05$) in the mean values of age, weight, height, and duration of illness between both tested groups (Table 1).

Table (1): Demographic Data of Patients in Groups A and B.

Items	Group A	Group B	Comparison		S
	Mean \pm SD	Mean \pm SD	t-value	P-value	
Age (yrs)	56.06 \pm 2.81	56.33 \pm 3.15	-0.244	0.809	NS
Body mass (Kg)	91.2 \pm 6.06	91 \pm 5.52	0.094	0.925	NS
Height (cm)	169 \pm 9.58	166.86 \pm 7.56	0.677	0.504	NS
Duration of illness (5-15years)	11.13 \pm 2.19	10.8 \pm 2.24	0.877	0.411	NS

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

1. Nerve conduction velocity of right and left deep peroneal nerve

As presented in table (2) and Fig. (3,4): the mean \pm SD values of nerve conduction velocity of right and left deep peroneal nerve in the "pre" and "post" tests were (38.02 \pm 3.6 and 41.25 \pm 2.71) - (36.86 \pm 2.54 and 40.6 \pm 2.23) respectively in the group (A). (p -value = 0.0001*). As well, the mean

\pm SD values of nerve conduction velocity of right and left deep peroneal nerve in the "pre" and "post" tests were (40.44 \pm 2.77 and 42.77 \pm 1.95) - (38.12 \pm 4.72 and 42.34 \pm 1.90) respectively the group (B). (P -value = 0.0001*). While, multiple pairwise comparison tests (Post hoc tests) revealed that there was no significant difference of the mean values of the "post" test between both groups with (P =0.102).

Table (2): Mean \pm SD and p values of nerve conduction velocity of right deep peroneal nerve pre and post test at both groups (A and B).

Nerve conduction velocity of right deep peroneal nerve	Pre treatment	Post treatment	MD	% of change	p-value
	Mean \pm SD	Mean \pm SD			
Group A	38.02 \pm 3.6	41.25 \pm 2.71	-3.22	8.4	\uparrow 0.0001*
Group B	40.44 \pm 2.77	42.77 \pm 1.95	-2.32	5.7	\uparrow 0.0001*
MD	-2.41	-1.51			
p-value	0.058	0.102			
Nerve conduction velocity of left deep peroneal nerve					
	Mean \pm SD	Mean \pm SD			
Group A	36.86 \pm 2.54	40.6 \pm 2.23	-3.73	10.11	\uparrow 0.0001*
Group B	38.12 \pm 4.72	42.34 \pm 1.90	-4.21	11.04	\uparrow 0.0001*
MD	-1.26	-1.74			
p-value	0.386	0.035*			

*Significant level is set at alpha level < 0.05

SD: standard deviation

MD: Mean difference

p-value: probability value

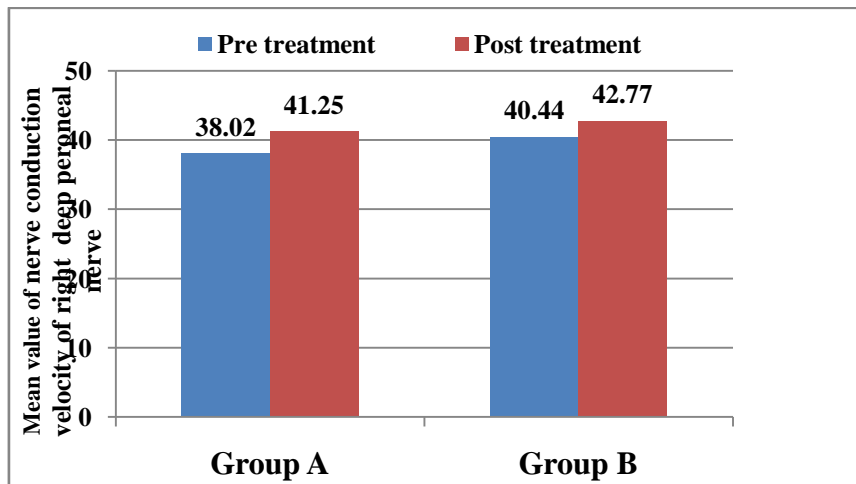


Fig. (3): Mean values of nerve conduction velocity of right deep peroneal nerve pre and post treatment in both groups (A and B).

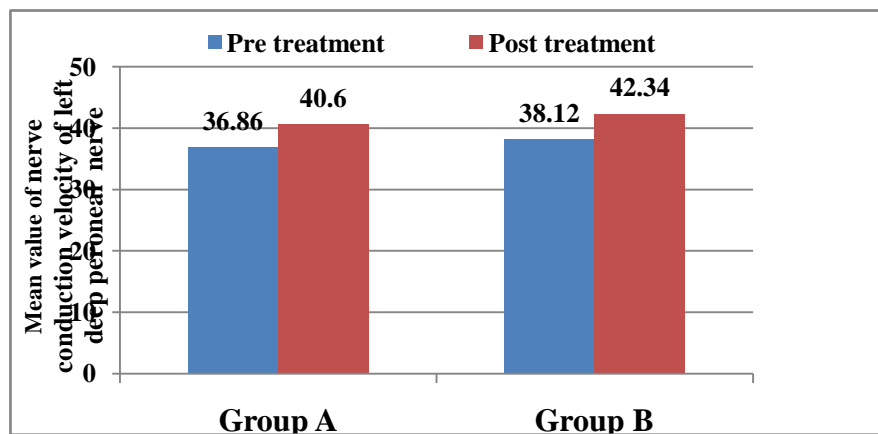


Fig. (4): Mean values of nerve conduction velocity of left deep peroneal nerve pre and post treatment in both groups (A and B).

2. Visual Analogue Scale (VAS)

As presented in table (3) and Fig (5) within group's comparison the mean \pm SD values of VAS in the "pre" and "post" tests were 7.5 ± 1.01 and 2.35 ± 0.49 respectively in group (A), (P-value =0.0001*). As well, the mean \pm SD values of VAS in the "pre" and "post" tests were 7.78 ± 0.89 and

2 ± 0.55 respectively group (B) , (P-value =0.0001*). While, multiple pairwise comparison tests (Post hoc tests) revealed that there was no significant difference of the mean values of the "post" test between both groups with (P=0.084).

Table (3): Mean \pm SD and p values of VAS pre and posttest at both groups (A and B).

VAS	Pre treatment	Post treatment	MD	% of change	p- value
	Mean \pm SD	Mean \pm SD			
Group A	7.5 \pm 1.01	2.35 \pm 0.49	5.14	68.5	↓ 0.0001*
Group B	7.78 \pm 0.89	2 \pm 0.55	5.78	74.2	↓ 0.0001*
MD	-0.28	0.35			
p- value	0.437	0.084			

*Significant level is set at alpha level <0.05
deviation

SD: standard

MD: Mean difference
probability value

p-value:

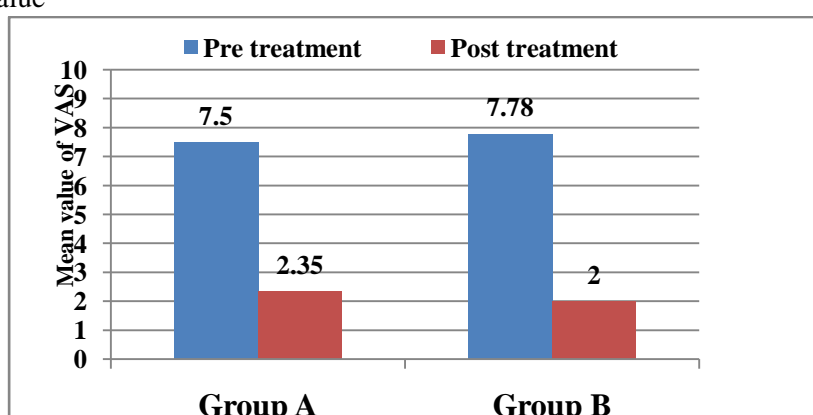


Fig. (5): Mean values of VAS pre and post treatment in both groups (A and B).

3. Quality Life Scale

As presented in table (4) and Fig. (6) within group's comparison the mean \pm SD values of quality life scale in the "pre" and "post" tests were 4.62 \pm 0.16 and 7.44 \pm 0.17 respectively in the group (A). (p-value =0.0001*). As well, the mean \pm SD values of quality life scale in the "pre" and "post"

tests were 4.60 \pm 0.16 and 7.46 \pm 0.17 respectively the group (B). (P-value=0.0001*). While, multiple pairwise comparison tests (Post hoc tests) revealed that there was no significant difference of the mean values of the "post" test between both groups with (P=0.747).

Table (4): Mean \pm SD and p values of Quality Life Scale pre and posttest at both groups (A and B).

Quality Life Scale	Pre treatment	Post treatment	MD	% of change	p- value
	Mean \pm SD	Mean \pm SD			
Group A	4.62 \pm 0.16	7.44 \pm 0.17	- 2.82	61	↑ 0.0001*
Group B	4.60 \pm 0.16	7.46 \pm 0.17	- 2.85	62	↑ 0.0001*
MD	0.02	-0.02			
p- value	0.824	0.747			

*Significant level is set at alpha level <0.05
MD: Mean difference

SD: standard deviation

p-value: probability value

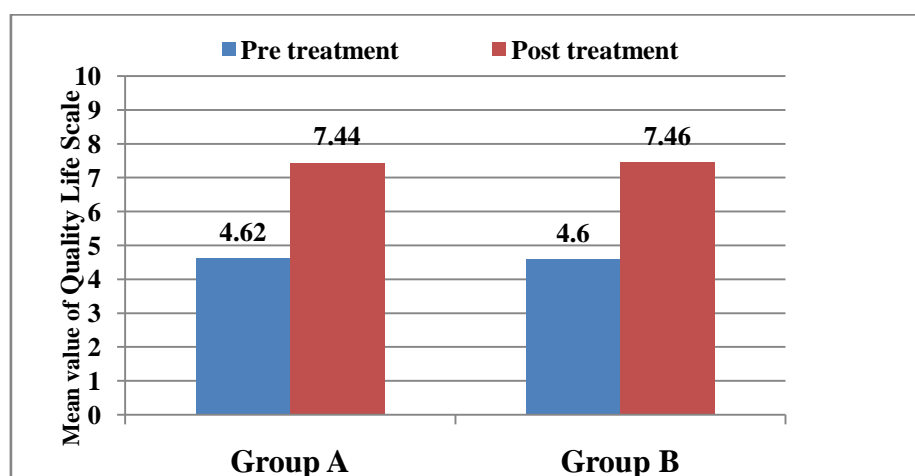


Fig. (6): Mean values of Quality Life Scale pre and post treatment in both groups (A and B).

DISCUSSION

From a pathophysiological standpoint, DPN is derived not only from injury to peripheral nerves, most commonly of microvascular origin [4,5], but repairing mechanisms are also defective including nerve growth factor and insulin-like growth factor [5]. So the treatment of DPN could be directed to improve microcirculation, enhance regeneration of nerve injury and reduce pain.

This current study aimed to compare between the effect of MIRE versus LLLT on nerve conduction velocity, pain intensity and functional activity of daily living in patients with DPN.

Thirty type 2 diabetes Patients with neuropathy especially in lower limbs. Their glucose level ranged between 130-350 mg/l and take oral hypoglycemic. Patient's ages ranged from 50 to 65 years. Clinically all patients suffered from glove and stock hypoesthesia, numbness, burning sensation, spasm of foot muscles and

muscle weakness of lower limbs. Patients have diabetes for more than 10 to 15 years (long standing diabetes). They were selected from out clinic of the faculty of physical therapy Cairo University and from the Coptic hospital. Subjects were randomly assigned into two groups :

Group A: 15 patients (n=15) received monochromatic infrared energy light for lower extremities for four weeks of treatment every other day three times per week.

Group B: 15 patients (n=15) received low level laser therapy for lower extremities for four weeks of treatment every other day three times per week

These measurements were recorded for both groups two times, before starting the study (pretreatment), and after four weeks from initial assessment (post treatment).

The analysis of results for both groups showed significant difference

for all variables. There was statistical significant difference between pre and post treatment within each group (A and B) for. But there was no statistical significant difference between groups (A and B) as regards to nerve conduction studies of deep peroneal nerve (NCV), visual analogue scale (VAS), functional activity of daily living.

The application of MIRE in patients with Diabetic foot neuropathy in group (A) revealed significant improvement in neuronal function to deep peroneal nerve where P value was 0.0001 and percentage of improvement was 10.11% using NCV studies. Also, use of MIRE revealed significant reduction in Pain intensity where P value was 0.0001 and percentage of improvement was 68.5% using Visual Analogue Scale. MIRE revealed also significant improvement in functional activity Of daily living where P value was 0.0001 and percentage of improvement was 61% using Diabetic 39(D – 39) .

The application of LLLT in patients with Diabetic foot neuropathy in group (B) revealed significant improvement in neuronal function to deep peroneal nerve where P value was 0.0001 and percentage of improvement was 11.04% using NCV studies. Also use of LLLT revealed significant reduction in Pain where P value was 0.0001 and percentage of improvement was 74.2% using Visual Analogue Scale. LLLT revealed also significant improvement in functional activity Of daily living where P value was 0.0001

and percentage of improvement was 62% using Diabetic 39(D – 39)

The control of neuropathic pain in patients with painful neuropathy is difficult; the previous studies have not used a treatment program based on anatomic and neuro pathophysiological source of neuropathic pain. So this study presents a new rationale and hypothesis for the successful treatment of chronic painful peripheral neuropathy.

Our findings had an agreement with the present study **Burke et al. 2003** who showed that treatment with monochromatic near infrared photo energy can reverse, to some degree, the symptoms in all diabetic subjects treated so far. An increase in microcirculation, measured at the skin surface, using a scanning laser Doppler (Moor Instruments), begins within minutes of MIRE exposure is significant (10-fold increase) after 20-30 min. treatment with the MIRE. The increased micro circulation persists for upwards of one hour. Photo energy mediated vasodilation may be due in part to the localized release of nitric oxide (NO) from the red blood cells (RBC) continuously passing through vessels exposed to the MIRE . Red blood cells are able to store large amounts of NO. Partly in the form of nitrosothiols and the absorption of this wavelength (890 nm) of photo energy by hemoglobin is well documented [30].

Moreover, **Tarek Ahmed (2012)** investigated the effects of Monochromatic infrared photo energy on reducing pain, improving sensation, and increasing balance in patients with diabetic peripheral neuropathy. Thirty-five patients with diabetic peripheral neuropathy completed the program and were randomly assigned into two groups. Group 1 (experimental, $n = 18$) received monochromatic infrared photo energy, therapeutic exercises, and balance training. Group 2 (control, $n = 17$) received therapeutic exercises and balance training. Both groups received three treatment sessions per week for 4 weeks. Outcome included pain intensity measured on a visual analogue scale, sensation measured with the Semmes-Weinstein monofilament 5.07, and balance measured with the Berg score, before and after the 12 therapy sessions (1 month after the start of the intervention). Analysis of covariance tests revealed statistically significant improvements, specifically, $P = .01$, $.014$, and $.0001$, for pain, sensation, and balance, respectively, in the experimental group. Within the limitations of this study, monochromatic infrared photo energy may play a role in treating diabetic peripheral neuropathy by reducing pain, improving sensation, and increasing balance [31].

Diabetic patients lack bioavailable nitric oxide (NO) resulting in poor blood supply in the foot. Monochromatic infrared energy or anodyne therapy has been used to

promote healing in diabetic foot ulcers, because it increases NO concentration in the blood stream and dilates blood vessels in the foot and these results agree with the present study (**James et al., 2004**)[32].

Moreover, **Chen et al. (2009)** have found evidence of nitric oxide (NO) release after exposure to low levels of red and near IR light. In addition to oxygen, hemoglobin also transports NO throughout the body. Nitric oxide is thought to aid in vascular perfusion by dilatation of arterioles, thus enhancing tissue oxygenation, nutrient delivery, and removal of waste products of metabolism. MIRE appears to accelerate healing at local sites where the MIRE pad is placed. This may be accomplished by liberating NO from hemoglobin or possibly from other nitrosylated compounds [33].

Also, **Lavery et al. (2007)** revealed that 69 patients with diabetes were involved in the study, using vibration perception threshold (VPT) as a tool to differentiate between sham group and active group. However, 60 patients managed to complete the course of treatment for 90 days at 40 minutes per day. Great toe and fifth metatarsal were tested and no significant differences obtained in the measurement of nerve conduction velocities for both groups. Hence, it was concluded that MIRE was no more effective than sham therapy in the treatment of sensory neuropathy [34].

Mark et al.(2006) make a study to determine whether restoration of sensation, impaired due to diabetic peripheral neuropathy (DPN), would reduce the number of falls and the fear of falling and improve activities of daily living (ADL) of patients with documented, monochromatic infrared phototherapy (MIRE) mediated, symptomatic reversal of DPN. Responses to a health status questionnaire following symptomatic reversal of DPN. Patients numbers were 252 (mean age 76 years) provided health information following symptomatic reversal of diabetic neuropathy (mean duration 8.6 months). Main results , incidence of falls and fear of falling decreased within 1 month after reversal of peripheral neuropathy and remained low after 1 year. Likewise, improved ADL were evident soon after reversal of peripheral neuropathy and showed further improvement after 1 year. Overall, reversal of peripheral neuropathy in a clinician's office and subsequent use of MIRE at home was associated with a 78% reduction in falls, a 79% decrease in balance-related fear of falling and a 72% increase in ADL ($P<0.0002$ for all results). Reversal of peripheral neuropathy is associated with an immediate reduction in the absolute number of falls, a reduced fear of falling and improved ADL. These results suggest that symptomatic reversal of diabetic neuropathy will have a substantial favorable, long-term socioeconomic impact on patients

with DPN and improve the quality of life for elderly patients with diabetes and peripheral neuropathy [35].

The results also were consistent with **Abeer (2012)** who showed that electro physiological parameters (Nerve conduction velocity NCV and amplitude) of peroneal motor nerve and sural sensory nerve and foot skin microcirculation were significantly increased in the laser group with no significant change in the control group. Also pain intensity level was significantly decreased in the laser group only. When comparing the post-treatment results of the groups, sural (NCV and amplitude), foot skin microcirculation and pain intensity, had significant differences in favour of the laser group; there was no significant difference in either peroneal NCV or amplitude [36].

Moreover, **Rochkind (2009)** found that laser improves function recovery and recruitment of voluntary muscle activity through application transcutaneously to the site of nerve injury (15 min) and to the corresponding segments of the spinal cord (15 min). The other studies concluded that laser irradiation prevents motor cell degeneration, induces Schwann cell proliferation, allows higher neural metabolism, and increases myelination and axon regeneration. An intriguing hypothesis would be that the improvement in cutaneous blood flow might be mirrored by a similar effect at the endoneural level, thus suggesting that an increment in nerve

blood flow might be a mechanism through which laser induces improvement of peripheral nerve function [37].

Our study results were supported also by **Lorne H. Zinman.(2008)** who conducted a randomized, double-masked, sham therapy-controlled clinical trial in 50 patients with painful Diabetic Sensory motor Polyneuropathy(DSP) diagnosed with the Toronto Clinical Neuropathy Score. All patients received sham therapy over a 2-week baseline period and were then randomized to receive biweekly sessions of either sham or low intensity laser therapy (LILT) for 4 weeks. The primary efficacy parameter was the difference in the weekly mean pain scores on a visual analog scale (VAS). The patients had similar baseline characteristics for pain intensity and duration of PDN. Both groups noted a decrease in weekly mean pain scores during sham treatment. After the 4-week intervention, the LLLT group had an additional reduction in weekly mean pain scores of -1.0 ± 0.4 compared with -0.0 ± 0.4 for the sham group ($P = 0.07$). LILT had no effect on the Toronto Clinical Neuropathy Score, nerve conduction studies, sympathetic skin response, or quantitative sensory testing. Although an encouraging trend was observed with LILT, the study results do not provide sufficient evidence to recommend this treatment for painful symptoms of Diabetic neuropathy [38].

The results were consistent with **Abeer et al. (2014)** Thirty diabetic neuropathy patients with pain and reduced nerve conduction velocity were randomly divided into two groups; an experimental group (active laser group, n=15) and a control group (placebo laser group, n=15). Peak static and dynamic planter pressure were measured under heel, big toe and little toe. Sural and Peroneal nerves conduction velocity and amplitude and pain level were measured before and after treatment in both groups. The active laser group had got scanning 850 nm He–Ne infrared laser on foot planter surface and [lumbosacral](#) area with 5.7 J/cm² for 15 min/site/session, 3 session /week for four weeks .found that Scanning He–Ne laser therapy with 850 nm that applied peripherally and centrally was an effective modality for improving nerve conduction, relieving pain and redistributing foot planter pressures of painful diabetic polyneuropathy patients [39].

Moreover, **Lazovic et al. (2014)** reported a significant improvement in sensory nerve velocity, sensory and motor distal latencies in patient with carpal tunnel syndrome treated by 830 nm and 780 nm LLLT with intensity 3.6 J/cm² and 2.7 J, 3.4 J/cm²/point respectively. Regarding the effect of 850 nm He–Ne laser on foot planter pressure distribution, the study found that the peak static planter pressure was decreased about 30.47%, 24.92% and 26.40% under the heel, big toe, and little toes respectively. Also the peak

dynamic planter pressure was decreased about 17.79%, 23.68% and 24.26% under the three areas respectively in comparing with baseline [40].

Shashi Kumaret al(2015) Painful DPN is associated with functional limitation & poor quality of life. Therefore, objective of the study is to find the effect of low level laser therapy on painful diabetic peripheral neuropathy (DPN) in type 2 diabetes mellitus (T2DM). The study design is pre-post observational design. After obtaining ethical clearance and informed consent, 19 T2DM subjects were screened and confirmed for peripheral neuropathy in an outpatient setting with biochemical parameter, pain scale and Michigan Neuropathy Screening Instrument (MNSI). Low Level Laser therapy was irradiated through scanning mode with dosage of 3.1J/cm² on the plantar and dorsum of the foot and 3.4j/cm² with contact method for 10days and all subjects were reassessed at the end of the 10 day. Descriptive statistics and paired' test was used to analyze the pre-post finding within the group. Level of significance was set at p <0.05. The result analysis showed significant reduction in Pain using VAS scale (6.47 ± 0.84 to 1.21 ± 0.78 (p<0.001), MNSI (5.52 ± 1.26 to 2.71 ± 0.97 (<0.001). In addition we observed significant reduction in Vibration perception threshold (32.68 ± 6.08 to 24.84 ± 4.29 (<0.001) and a significant increase in the temperature from baseline to post intervention (30.01 ± 2.11 to 31.75 ± 1.03 (p<0. 001). In the present study,

Low level laser therapy was found to be effective in type 2 DM with peripheral neuropathy [41].

The results from the previous studies confirmed that monochromatic infrared photo energy and low level laser therapy both are an effective physical therapy modality in treatment of diabetic neuropathy and solving the related disorders of this disease as reducing pain, improving sensation, motor power and conduction velocity of nerves.

Finally, this study concluded that monochromatic infrared (890 nm) photo energy (MIRE) by anodyne therapy and low level laser therapy (LLLT) would improve neural function lost in diabetic patients. Both MIRE and LLLT are an effective, noninvasive, drug free and very safe modality helps to decrease pain and improve performance of daily living. Therefore physical therapy program must be combined with MIRE or LLLT in diabetic neuropathy.

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