A Comparative Study of Low-Level Laser Therapy and Short-Wave Diathermy in the Management of Peripheral Diabetic Neuropathy of the Lower Extremity

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KEYWORDS
Peripheral Diabetic Neuropathy, Low-Level LASER Therapy, Short-wave Diathermy, Physiotherapy.

ABSTRACT

Background: Diabetic peripheral neuropathy (DPN) is a common complication of diabetes mellitus, causing pain, numbness, and reduced sensation. Effective management is essential, as pain often disrupts daily functioning and sleep. Pharmacological treatments have side effects, leading to increased interest in non-pharmacological therapies.

Objective: To compare the effectiveness of Low-Level Laser Therapy (LLLT) and Short -Wave Diathermy (SWD) in managing pain and symptoms associated with DPN.

Methods: Two groups were treated with LLLT (Group A) and SWD (Group B). Outcomes were measured using the Numeric Pain Rating Scale (NPRS) and Treatment-Induced Neuropathic Assessment Scale (TNAS 3.0). Statistical analysis (t-tests) compared the effects of the treatments within and between groups.

Results: Both treatments showed significant improvements in pain reduction (NPRS) and neuropathy symptoms (TNAS 3.0). SWD demonstrated significant effect on pain, while LLLT showed for functional improvements.

Conclusion: Both LLLT and SWD are effective for managing DPN, with each offering specific advantages.

1. Introduction

Peripheral neuropathy, is a frequent side effect of diabetes mellitus Type 1 as well as Type 2 . It is estimated that up to 36% of people with non-insulin-dependent diabetes mellitus have this progressive, irreversible illness. Diabetic peripheral neuropathy is characterized by discomfort, reduced sensations, and/or numbness. There have also been reports of painful symptoms like burning, pins and needles, shooting pain, and hyper-aesthesia.(4) Pain is often worst at night and might keep a patient from sleeping through the night.(1) Since the cause and pathophysiology of the symptoms caused by peripheral neuropathy not well known, the majority of treatment for Peripheral neuropathy patients is symptomatic and includes analgesics, anticonvulsants, opioids, and tricyclic antidepressants(2).Acute and chronic hyper-glycemia, microvascular anomalies, nitric oxide shortage, genetic and environmental variables, and nerve compression are among the hypo-thesis aetiological reasons. Multifactorial pathogenesis seems to be the case. The degree of neuropathy appears to be correlated with pathological alterations in the endo-neural capillary.

Diabetes Mellitus affects distal parts of the body and cause vascular and neurological compromises. It mainly affects the Common Peroneal Nerve followed by the Tibial Nerve because they are situated on the superficial side of the leg (3). Diabetes affects the nerve conduction velocity and is also responsible for delayed nerve conduction and perhaps delayed reflexes, altered sensation and severe pain. The nerves of the foot are compromised hence leading to Balance, coordination and gait difficulties. All the above eventually lead to difficulty in performing Activities of daily living. Work Life Balance id disturbed (5).

Alongside the conventional method of controlling Blood Sugar Levels with Pharmacological Therapy and other preventive strategies to avoid secondary complications, Physiotherapy as a whole has worked wonders in managing Peripheral Diabetic Neuropathy. Physiotherapeutic intervention of symptomatic management and pain relief is essential in maintaining Physiological functions of the body.(6)

Electrotherapy is also proved to be beneficial in order to reduce the pain and aesthesia of the patient.

Low Level LASER therapy: Nonpharmacologic therapies, such as low-intensity laser therapy (LLLT), is effective adjunctive or alternative treatments for painful Diabetic Sensory Polyneuropathy with avoidance of systemic drug adverse effects.(3) LILT has been linked to biologic benefits such as quicker trauma recovery. According to one investigation, the tensile strength of laser-treated wounds dramatically improved at one and two weeks following treatment, and after two weeks, the collagen content rose even more. Additionally encouraging are studies on LILT's impact on the peripheral nervous system. After a crush injury, the rate of regeneration of nerve was accelerated by low power laser(4)

Short wave diathermy (SWD): Shortwave diathermy (SWD) is a treatment that uses high-frequency electromagnetic radiation to treat diabetic neuropathy and other conditions. SWD can help with diabetic neuropathy by: Reducing pain: SWD can help with neuropathy pain by modulating pain impulses to the brain. Increasing circulation: SWD can increase vascular circulation and change tissue temperature. Accelerating healing: SWD can help with chronic inflammation by reducing pain, swelling, and accelerating tissue healing. Increasing heat shock proteins (HSP), which help repair intracellular proteins and speed up cell and tissue healing Stimulating the release of enkephalins, dynorphins, and endorphins(1)

This **aim** is to compare the effectiveness of low-level laser therapy and Short-wave diathermy in the management of diabetic neuropathy of the lower extremity.

The Objectives of this study are as follows:

1. To find out **the effects of low-level laser therapy on diabetic neuropathy** patients on parameters of NPRS and Treatment induced Neuropathic assessment scale 3.0.
2. To find out the **effects of Short-wave diathermy on diabetic neuropathy patients** on parameters of NPRS and Treatment induced Neuropathic assessment scale 3.0.

To compare **the efficiency of low-level laser therapy and Short-wave diathermy in patients of diabetic neuropathy** using NPRS, Strength-Duration Curve and Treatment induced Neuropathic assessment scale.

2. Materials and Methodology

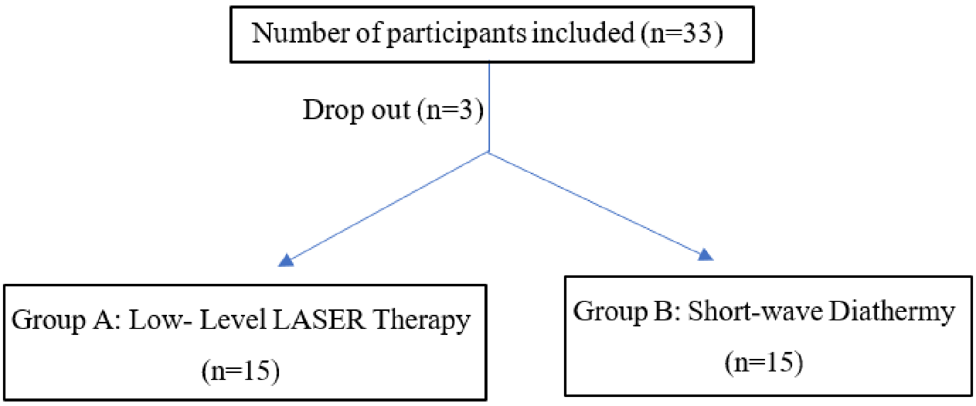
This Experimental Study was conducted in Dr. D. Y. Patil College of Physiotherapy, Pune. This study was conducted on patients having diabetic neuropathy of the lower extremity. The method of sampling done was Simple random sampling by using manual lottery method. The total sample size of the project was 24 with reference to the article considered the mean difference of 1.1 and standard deviation of 1.7, the required sample size would be 24 (30 samples will be taken into account) with the effect size of 0.6 and error probability of 0.05. Power of the study will be 80%. Sample size calculated using G* Power software version 3.1.9.4. Total number of participants were 33 out of which 3 dropped out due to non-feasibility for treatment. The inclusion criteria was as follows: men and women who are between the age of 30- 80 with Type 2 diabetes mellitus and are currently on medications for the same. Men and women who have complaints of neuropathies of the lower extremity occurring due to the presence of Type 2 diabetes Mellitus. The exclusion criteria was participants under the age of 30, participants with Type 1 diabetes mellitus, participants having Sensory Impairments like hyposensitivity or hypersensitivity. The outcome measures taken were Numerical Pain Rating Scale and Treatment Induced Neuropathic Assessment Scale 3.0.

3. Materials Required

Low Level LASER Therapy Machine

- Short wave Diathermy Machine
- Towel
- Assessment Sheets
- Consent form

The study is an experimental study to see the effect of Low-Level LASER therapy and Short -Wave Diathermy in Diabetic Neuropathy Patients who complaint of pain, numbness in the lower extremity. It was a 3 Days interventional study in which patients were categorized in 2 groups. Group A consist of the patients who were treated with Low Level LASER, on the other hand Group B consists of patients who were treated with Short Wave diathermy. On day 1 of the study, the patients with diabetic neuropathy were be given a questionnaire consisting of their demographic data, according to the intensity of pain they are experiencing by Numerical Pain Rating Scale (NPRS), and through an outcome measure that is a Treatment induced Neuropathic Assessment Scale (TNAS 3.0). After the treatment is continued for 3 days, the same outcome measure was re-assessed and the pain, and the level of neuropathy was compared between Group A and Group B . The study concluded by a data analysis of the difference between the day 1 and day 3 of the therapy in a patient treated with Low level Laser therapy and Short-wave diathermy.



4. Results

Summary: Within-Group vs Between-Group Comparisons

Within-Group Comparisons:

The within-group comparisons show the effect of the treatments (Low-Level Laser Therapy in Group A and Short Wave Diathermy in Group B) on each of the two outcome measures: **NPRS** (Numeric Pain Rating Scale) and **TNAS 3.0** (likely a specific functional or symptom assessment scale). Here's a brief summary:

A. **Group A (Low-Level Laser Therapy)**:

- **NPRS**: T-statistic = **8.29**, P-value = **9.02e-07** (highly significant). This shows a substantial impact of the treatment on pain reduction.
- **TNAS 3.0**: T-statistic = **5.58**, P-value = **6.84e-05** (also significant, but less so than NPRS). The treatment has a significant effect on this measure too, but the significance is less pronounced compared to NPRS.

B. **Group B (Short Wave Diathermy)**:

- **NPRS**: T-statistic = **10.35**, P-value = **6.12e-08** (very highly significant). This indicates a very strong effect on pain reduction.
- **TNAS 3.0**: T-statistic = **5.17**, P-value = **0.00014** (significant, but less so than NPRS). Short Wave Diathermy shows significant effects on this measure, though slightly less pronounced than on NPRS.

Between-Group Comparisons (NPRS & TNAS 3.0):

We now compare the **NPRS** and **TNAS 3.0** measures between **Group A (Low-Level Laser Therapy)** and **Group B (Short Wave Diathermy)**. To determine which treatment is more effective, we compare the **p-values** and statistical significance across groups:

A. **Group A vs Group B - NPRS:**

- **Group A** NPRS: T-statistic = **8.29**, P-value = **9.02e-07**
- **Group B** NPRS: T-statistic = **10.35**, P-value = **6.12e-08**

Interpretation: Both groups show highly significant effects on pain reduction, with Group B (Short Wave Diathermy) showing a slightly more significant effect (smaller p-value). This suggests that Short Wave Diathermy might be more effective at reducing pain compared to Low- Level Laser Therapy based on NPRS scores, although both are highly effective.

B. **Group A vs Group B - TNAS 3.0:**

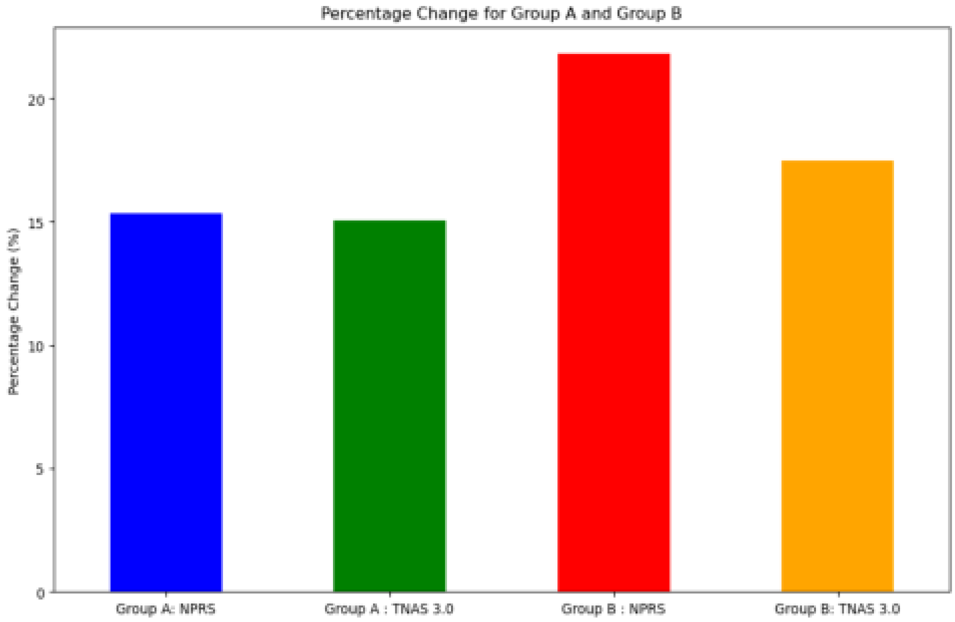
- **Group A** TNAS 3.0: T-statistic = **5.58**, P-value = **6.84e-05**
- **Group B** TNAS 3.0: T-statistic = **5.17**, P-value = **0.00014**
- **Interpretation**: Both treatments show significant improvements in TNAS 3.0 scores, but **Low-Level Laser Therapy (Group A)** has a slightly stronger effect (smaller p-value), suggesting that it might be marginally more effective than Short Wave Diathermy on this measure.

Summary of Results:

- **Within-Group Analysis**:
  - Both **Group A (Low-Level Laser Therapy)** and **Group B (Short Wave Diathermy)** show highly significant improvements in **NPRS** (pain reduction), with **Group B** showing a slightly stronger effect.
  - For **TNAS 3.0**, both treatments are also significant, but **Group A** (Low-Level Laser Therapy) appears to show a slightly stronger effect than **Group B** (Short Wave Diathermy).
- **Between-Group Comparison**:
  - **NPRS**: **Group B** (Short Wave Diathermy) appears slightly more effective at reducing pain, as indicated by its more significant result (smaller p-value).
  - **TNAS 3.0**: **Group A** (Low-Level Laser Therapy) shows a slightly stronger effect on this measure, with a lower p-value indicating a more significant treatment impact.
- **Pain Reduction (NPRS)**: **Group B (Short Wave Diathermy)** appears to be slightly more effective at reducing pain based on the **p-value** (Group B has the smaller p-value).
- **TNAS 3.0**: **Group A (Low-Level Laser Therapy)** shows a slightly stronger effect, as indicated by the smaller **p-value**.\

Comparision by % change in pre and Post

Group A: NPRS	Group A: TNAS 3.0	Group B: NPRS	Group B: TNAS 3.0
25	12.90322581	28.57142857	17.64705882
14.28571429	9.090909091	25	38.80597015
16.66666667	0	25	28.57142857
0	15.49295775	14.28571429	8.450704225
12.5	12.06896552	12.5	7.692307692
22.22222222	17.33333333	16.66666667	10
25	18.75	33.33333333	6.25
12.5	16.47058824	28.57142857	10.95890411
12.5	30	12.5	6.666666667
14.28571429	35.48387097	23.07692308	38.46153846
11.11111111	6.25	14.28571429	6.666666667
12.5	12.5	28.57142857	7.692307692
14.28571429	18.75	28.57142857	46.66666667
12.5	7.142857143	25	16.66666667
25	13.33333333	11.11111111	11.25
AVG Change			
15.35714286	**15.03800274**	**21.8030118**	**17.49645909**



5. Results

Both treatments show significant effects, but **Short Wave Diathermy** shows slightly more effective in reducing pain (**NPRS)** and Treatment Induced Neuropathic Assessment scale **3.0 (TNAS 3.0)** statistically. Although it can be noted that a significant improvement is seen in Low- Level Laser Therapy clinically.

6. Discussion

Diabetic peripheral neuropathy (DPN) is a prevalent and debilitating complication of diabetes, affecting a significant portion of the population with both Type 1 and Type 2 diabetes. With up to 36% of individuals with non-insulin-dependent diabetes mellitus (Type 2) suffering from this condition, the implications are profound, with symptoms ranging from discomfort, numbness, and reduced sensations to more severe pain, including burning, pins and needles, and shooting sensations. This pain, often exacerbated at night, can interfere with sleep and significantly impact the quality of life for individuals affected by DPN. Despite the widespread nature of this condition, the exact pathophysiology remains unclear, and as such, treatment approaches are largely symptomatic, focusing on pain relief and managing other associated symptoms(1)

Pharmacological management typically includes analgesics, anticonvulsants, and opioids, though these can have significant side effects, leading to a growing interest in alternative therapies. Physiotherapy, alongside pharmacological treatment, has demonstrated significant benefits in managing DPN (2). Interventions such as electrotherapy have been shown to alleviate pain and discomfort, making it a crucial part of a comprehensive management strategy. Low- Level Laser Therapy (LLLT) and Short-Wave Diathermy (SWD) are two modalities that have garnered attention for their potential efficacy in managing diabetic sensory polyneuropathy.

The results from within-group comparisons of the two treatment groups—LLLT and SWD— highlight the effectiveness of both modalities (4). LLLT, which utilizes low-intensity laser energy to reduce pain and promote healing, was found to have a statistically significant effect on both pain reduction, as measured by the Numeric Pain Rating Scale (NPRS), and the Treatment-Induced Neuropathic Assessment Scale (TNAS 3.0). The NPRS results for Group A (LLLT) showed a highly significant reduction in pain (T-statistic = 8.29, $p = 9.02e{-}07$), with similar, though slightly less significant, results on the TNAS 3.0 scale (T-statistic = 5.58, $p = 6.84e{-}05$).(3)

On the other hand, SWD, which uses high-frequency electromagnetic radiation to promote circulation and modulate pain, also demonstrated a strong effect. Group B (SWD) showed a very highly significant reduction in pain on the NPRS (T-statistic = 10.35, $p = 6.12e{-}08$), and although the effect on TNAS 3.0 was significant, it was slightly less pronounced than the effect observed in Group A (T-statistic = 5.17, $p = 0.00014$).(5)

When comparing the two groups, the results suggest that while both LLLT and SWD are highly effective, SWD may have a slight edge in terms of pain reduction, as evidenced by its more significant impact on the NPRS. However, LLLT appears to have a marginally stronger effect on improving functional and symptomatic outcomes as measured by TNAS 3.0. This dual benefit of LLLT on both pain and functional scores might make it a preferable choice for some patients.(3)

In conclusion, both Low-Level Laser Therapy and Short Wave Diathermy are highly effective interventions for managing diabetic peripheral neuropathy, with each offering unique advantages. While SWD may be slightly more effective in reducing pain, LLLT demonstrates a more pronounced improvement in functional outcomes. A combination of these therapies, tailored to the individual needs of the patient, could offer optimal management of this challenging condition.

7. Limitations

i. This study is conducted in a small population

ii. This study does not include participants

8. Future Scope

This study can be conducted in other patients other than Diabetic Peripheral Neuropathy patients.

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