International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

# Effectiveness of Photobiomodulation Therapy in Improving Nerve Function in Common Peroneal Neuropathy: Randomized Clinical Trial

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**ABSTRACT**

**Background:** Common peroneal nerve (CPN) is the most common mononeuropathy encountered in lower limb often resulting in foot drop**.** CPN Injuries have a variety of traumatic and non-traumatic aetiologies. Trauma-related injuries include musculoskeletal or orthopedic damage, while non-traumatic causes involve neurological disorders and compressive pathologies. **Objectives:** To determine the effectiveness of Photobiomodulation therapy (PBMT) on Nerve Conduction Velocity, Muscle Strength and Ankle-foot Disability Index in individuals with CPN injuries.

**Methodology:** The present study was a Prospective Randomized Clinical Trial in nature in which the effect of PBMT was observed**.** A total of 14 participants diagnosed with foot drop was randomly allocated into two independent groups that is Group A (Experimental Group) and Group B (Control Group). **Results:** The mean FADI scores for Group A improved from 50.0 ± 15.48 (Day 0) to 57.43 ± 17.39 (Day 14) ($p > 0.05$), while Group B improved from 39.86 ± 15.27 to 44.14 ± 16.18 ($p > 0.05$), showing no significant intragroup changes. Between-group comparisons at Day 14 also showed no significant differences ($p > 0.05$). Dorsiflexor strength increased from 1.15 ± 0.62 to 1.66 ± 1.05 in Group A and from 0.86 ± 0.71 to 1.16 ± 0.70 in Group B ($p > 0.05$). MNCV in Group A increased from 31.96 ± 19.91 to 38.31 ± 19.61 ($p > 0.05$). Overall, clinical improvements were observed but not statistically significant. **Conclusion:** The study found greater improvement with PBMT plus conventional physiotherapy compared to physiotherapy alone, though results were clinically non-significant. This is the first study to assess PBMT in CPN injury. Future research with larger samples and longer durations is recommended.

**Keywords:** Common peroneal nerve (CPN) injury, Foot drop, Mononeuropathy, Photobiomodulation therapy (PBMT), Nerve conduction velocity (NCV), Muscle strength, Ankle-Foot Disability Index (FADI), Dorsiflexor weakness, Neuropathy rehabilitation, Physiotherapy, Prospective randomized clinical trial, Low-level laser therapy, Peripheral nerve injury, Neuromuscular recovery, Compressive neuropathy

## Introduction

Common peroneal nerve is the primary peripheral nerve that innervates the lower extremity (Yang Jinseo et al., 2022). It is also known as common fibular nerve supplies the fibres to the posterior divisions of L4-S2 nerve roots (Abdolhoseinpour et al., 2022). Foot drop is a sequalae of common peroneal nerve injuries which is described as weakening or paralysis of the peroneal and anterior tibialis muscles, which impairs functional mobility, gait, and balance disturbances (Aldemir et al., 2017). Epidemiological studies report that CPN injuries due to trauma are frequently observed in young athletes and adults, with males more commonly affected than females. Both left and right limbs are equally involved (Nori et al., 2020). The prevalence of foot drop in Egypt ranges from 19 to 40 per 100,000 individuals (Oosterbos et al., 2022). In the United States, 1,787 hospital admissions related to foot drop were recorded in 2009, as reported by the Agency for Healthcare Research and Quality (Osta et al., 2019). Foot drop is characterized by difficulty in lifting the forefoot, leading to dragging of the foot or compensatory excessive flexion of the hip and knee, resulting in a high steppage gait (Osta et al., 2019). Foot drop is evaluated through comprehensive history taking and physical examination, including gait and balance assessment, dorsiflexor muscle strength testing, and radiological imaging (Nori et al., 2020). Electrodiagnostic studies such as nerve conduction velocity (NCV) tests and electromyography (EMG) are commonly used to assess motor and sensory axons of the peroneal nerve and its branches (Mustafa et al., 2016). NCV tests measure latency, amplitude, and conduction velocity, providing insights into the functional integrity of myelin (Paoge et al., 2016) Conservative physiotherapy management for foot drop includes ankle-foot orthoses, functional electrical stimulation (FES), gait training, neuromuscular facilitation and faradic foot bath (Carolus et al., 2019). Conventional treatment for CPN regeneration is not much effective so there is need to search advanced techniques for CPN regeneration in case of foot drop. So in this study, in addition to conventional physiotherapy, the innovative treatment method for foot drop includes Photobiomodulation (PBMT) using Class IV LASER (Light Amplification by Stimulated Emission of Radiation.

PBMT is a precise, non-invasive technique that promotes neuronal regeneration by stimulating cellular metabolism and accelerating tissue repair. Its effects arise from photon absorption by cytochrome c oxidase in the mitochondrial respiratory chain, enhancing blood perfusion and cellular function (Dompe et al., 2020; Rosso et al., 2018). The therapeutic dose follows the Arndt-Schultz principle (Larkin et al., 2012). Due to its regenerative properties, PBMT is increasingly used in clinical practice. Current study investigates its impact on nerve conduction in individuals with CPN injuries.

## Material And Methods

This experimental study was conducted at the Neurology OPD, Department of Physiotherapy, Punjabi University Patiala; Giani Lal Singh Memorial Hospital Patiala; Kanishk clinic Patiala; Osteocare Clinic Patiala; Neuroots; Patiala. The international Ethical clearance was obtained from the Institutional Ethical Committee of Punjabi University, Patiala (reference no. 25/55/IEC/PUP/2022). Informed consent was acquired from all participants after providing a patient information sheet in a language they could understand. A total of 200 subjects were screened based on inclusion and exclusion criteria using a structured screening performa from which 22 individuals with peroneal nerve injuries participated in the study. Out of which 14 participants completed the trial.. These individuals were randomly assigned to two groups: Experimental Group A (n=7) and Control Group B (n=7). Demographic details, including age, gender, occupation, hand dominance, and address were recorded.

Experimental Group A underwent a multi-step physiotherapeutic approach administered over a two-week period. Initially, the participant was positioned supine, and Photobiomodulation Therapy (PBMT) was applied perpendicularly to the treatment area using a hand-held probe, with dosage tailored to the area size to induce a soothing warmth. This was followed by 15 minutes of Functional Electrical Stimulation (FES). Subsequently, balance training, including both static and dynamic exercises on a Swiss ball, was provided alongside conventional physiotherapy. Gait training was then conducted on a treadmill for 10 minutes using an assistive device, with or without body weight support based on the participant’s condition. Each session lasted 45 minutes. Motor Nerve Conduction Studies and outcome assessments were recorded on Day 0 and Day 14.

Control Group B received conventional treatment comprising two main steps. First, they were positioned comfortably in a lying posture, and Functional Electrical Stimulation (FES) was applied. This was followed by 30 minutes of conventional physiotherapy, including neuromuscular facilitation techniques, balance and gait training, and calf and Achilles tendon release. Each session lasted 45 minutes, delivered five times per week over two weeks. Motor nerve conduction velocity was assessed on Day 0 and Day 14, while muscle strength was evaluated weekly using the ActivForce2 Dynamometer. Ankle-foot disability was assessed using a standardized scale.

## Result

The data analysis was conducted using SPSS version 16.0. A total of 14 participants diagnosed with foot drop due to common peroneal nerve injury were enrolled and randomly allocated into two groups: Group A (Experimental; n=7), who received Photobiomodulation Therapy (PBMT) along with conventional physiotherapy, and Group B (Control; n=7), who received only conventional physiotherapy. The primary outcome was Motor Nerve Conduction Velocity (MNCV), while secondary outcomes included dorsiflexor muscle strength and Ankle-Foot Disability Index (FADI) scores.

**Demographic profile of study participants:**

**Table1: Mean and SD of Age for the subjects of Group A and Group B**

| Demographic Characteristics | Group A (Mean ±SD) | Group B (Mean ± SD) |
|---|---|---|
| **Age** | 34.43 ± 17.20 | 49.57 ± 19.98 |

**Table 2: Distribution of Participants according to their Gender in Group A and Group B**

| Gender | Group A (Number of Participants) | Group B (Number of Participants) |
|---|---|---|
| **Male** | 7(100%) | 7(100%) |
| **Female** | 0(0%) | 0(0%) |

**Table 3: Comparison of mean score for muscle strength and FADI Score at Day 0, Day 7 and Day 14 between Group A and Group B**

| Assessment | Time Period | Group A Mean± SD | Group B Mean± SD | t-Value | p-value |
|---|---|---|---|---|---|
| **Muscle Strength** | DAY0 | 1.15±0.62 | 0.86±0.71 | 0.814 | p>0.05 |
| | DAY7 | 1.50±1.04 | 0.92±0.74 | 1.205 | p>0.05 |
| | DAY14 | 1.66±1.05 | 1.16±0.70 | 1.044 | p>0.05 |
| **FADI score** | DAY0 | 50±15.48 | 39.86±15.27 | 1.234 | p>0.05 |
| | DAY7 | 54.29±16.7 | 41.43±15.37 | 1.499 | p>0.05 |
| | DAY14 | 57.43±17.3 | 44.14±16.18 | 1.480 | p>0.05 |

**Table 4: Comparison of mean score for FADI Score and muscle strength at Day 0, Day 7 and Day 14 within Group A and Group B**

| Output Measure | Group | Day 0 Mean± SD | Day 7 Mean± SD | Day 14 Mean± SD | F value | P value | Significance level |
|---|---|---|---|---|---|---|---|
| **FADI Score** | A | 50.0 ± 15.48 | 54.29±16.70 | 57.43±17.39 | 0.356 | p>0.05 | Non-significant |
| | B | 39.86± 15.27 | 41.43±15.37 | 44.14±16.18 | 0.135 | p>0.05 | Non-significant |
| **Muscle strength** | A | 1.15±0.62 | 1.50±1.04 | 1.66±1.05 | 0.568 | p>0.05 | Non-significant |
| | B | 0.86±0.71 | 0.92±0.74 | 1.16±0.70 | 0.352 | p>0.05 | Non-significant |

**Table 5: Comparison of Mean and SD of MNCV at DAY 0 and DAY 14 for the subjects of Group A**

| MNCV | Day0 (Mean±SD) | Day 14 (Mean±SD) | Mean Difference (0-14 Day) | t Value | P Value | Significance level |
|---|---|---|---|---|---|---|
| **Group A** | 31.96±19.91 | 38.31±19.61 | 6.35±16.799 | -1.002 | P>0.005 | Non-Significant |

**A total of 14 participants were randomly assigned into two experimental groups:** The demographic characteristics of the participants in the present study are presented below. The mean age (± standard deviation) of participants in Group A (n=7) was 34.43 ± 17.20 years, whereas in Group B (n=7), it was 49.57 ± 19.98 years. Regarding gender distribution, all participants in both Group A and Group B were male.

Outcome measures for both groups included the Foot Ankle Disability index (FADI Score), Muscle strength and MNCV assessed at Day 0, Day 7 and Day 14 follow-up. Experimental Group A received interventions Photobiomodulation therapy (PBMT), Functional electrical stimulation, Balance training and Gait training with assistive device and other related activities. Experimental Group B, on the other hand, engaged in exercises FES and Conventional physiotherapy which includes neuromuscular facilitation, balance training, gait training, calf and Achilles tendon release. Both groups participated in these interventions five times a week for a total of two weeks.

Within group analysis indicated clinical improvements in gait, balance and functional limitations but the results were statistically non-significant as measured by the FADI scale. The mean scores of FADI for Group A were 50.0 ± 15.48, 54.29±16.70 and 57.43±17.39 on Day 0, Day 7 and Day 14 respectively with F=0.356 and p>0.05 which depicts statistically non-significant results whereas for Group B the mean scores were 39.86± 15.27, 41.43±15.37 and 44.14±16.18 on Day 0, Day 7 and Day 14 respectively with F=0.135 and p>0.05 which depicts statistically non-significant results.

For Muscle strength, both groups showed clinical improvements within Group A and Group B. However, the results were non-significant as measured by Activ force2 Dynamometer due to small sample size and short day protocol. The mean scores dorsiflexors muscle strength for Group A were 1.15±0.62, 1.50±1.04

and 1.66±1.05 on Day 0, Day 7 and Day 14 respectively with F=0.568 and p>0.05 which depicts statistically non-significant results whereas for Group B the mean scores were 0.86±0.71, 0.92±0.74 and 1.16±0.70 on Day 0, Day 7 and Day 14 respectively with F=0.352 and p>0.05 which is statistically non-significant.

For Motor Nerve Conduction Velocity the mean values of motor nerve conduction velocity at Day 0 and Day 14 for Group A were 31.96±19.91 and 38.31±19.61. On comparison Day 0 vs Day 14 t value was -1.002 and p>0.005 which shows that results were non-significant for motor nerve conduction velocity but clinical improvements were visible.

Between group analysis revealed that the mean values of muscle strength were 1.15±0.62 and 0.86±0.71 for Group A and Group B respectively at Day0 with t-value 0.814 and p>0.05 which is statistically non-significant. The mean scores at Day 7 for Group A and Group B were 1.50±1.04 and 0.92±0.74 respectively with t-value 1.205 and p>0.05. The mean scores at Day 14 for Group A and Group B were1.66±1.05and 1.16±0.70 respectively with t-value 1.044 and p>0.05. On comparison of the mean difference scores (Day 0 - Day 14) for Group A and Group B were 0.51±0.57 and 0.31±0.40 respectively and the results showed statistically non-significant with p>0.05 and t-value of 0.787.

The Mean values for FADI score at Day 0 were 50±15.48 for Group A and 39.86±15.27 for Group B with t-value 1.234 and p>0.05. This statistically non-significant difference represents that Group A and Group B were similar prior to the interventions. The mean scores at Day 7 for Group A and Group B were 54.29±16.70 and 41.43±15.37 respectively with t-value 1.499 and p>0.005. The mean scores at Day 14 for Group A and Group B were 57.43±17.39 and 44.14±16.18 respectively with t value 1.480 and p>0.05. It has been reported that change in mean scores was statistically non-significant (p>0.05) for all the three intervals. Also, on comparison of the mean difference scores for both the groups, the results showed statistically non-significant results and t-value of 1.019.

Although the results were non-significant between Group A and Group B but clinical improvements were there in walking pattern, functional independence and dorsiflexion muscle strength.

## DISCUSSION

Foot drop is characterized by the inability or difficulty in lifting the forefoot, typically due to weakness or paralysis of the dorsiflexor muscles (Nori et al., 2020). This condition significantly affects gait mechanics and increases the risk of falls and injuries, thereby impairing functional mobility and quality of life (Yap & McNamara, 2016).

The present randomized controlled trial investigated the effects of Photobiomodulation Therapy (PBMT) using Class IV LASER in combination with conventional physiotherapy on nerve conduction velocity, muscle strength, and functional disability in individuals with foot drop caused by common peroneal nerve injuries. Although the results were statistically non-significant across most parameters, clinical improvements were observed in the experimental group receiving PBMT. Improvements were seen in motor nerve conduction, dorsiflexor muscle strength, and Foot and Ankle Disability Index (FADI) scores.

### Between-Group Comparison

At Day 14, muscle strength in the PBMT group (Group A) increased more than in the control group (Group B), though the results were statistically non-significant (p > 0.05). This suggests a potential clinical benefit of PBMT in enhancing dorsiflexor muscle strength. Previous literature, such as Pratama et al. (2021), supports this trend, reporting improved muscle girth and walking patterns after laser therapy in foot drop patients.

Group A also demonstrated greater improvement in FADI scores compared to Group B at Day 14 (mean difference of 7.43 vs 4.29), indicating improved functional ability. However, statistical significance was not achieved ($p > 0.05$). Clinical relevance was supported by earlier studies showing functional gains following laser therapy, although the current study's short intervention period may have limited the ability to detect significant differences.

**Within-Group Comparisons**

Within Group A, nerve conduction velocity improved from 31.96 ± 19.91 to 38.31 ± 19.61, but results were statistically non-significant ($p > 0.005$). These findings do not fully support earlier reports by Ezzati et al. (2020), which found significant improvements with high-intensity laser therapy. This discrepancy may be due to the limited 2-week duration in the present study.

Both groups showed improved dorsiflexor strength by Day 14, with greater gains in Group A. While the change was statistically non-significant, the increase was more pronounced in the PBMT group (mean difference: 0.51 vs 0.31), supporting the hypothesis that PBMT may accelerate muscle recovery, possibly via enhanced local circulation and nerve regeneration.

FADI scores improved in both groups over the 2-week period, with higher gains in the PBMT group. Although the p-values did not indicate statistical significance, the improvement in activities of daily living, standing, walking, and balance support a clinically beneficial trend. These findings align with Kolu et al. (2018), who noted improvements in similar functions with laser-assisted rehabilitation.

Although statistical significance was not achieved, the **clinical improvements** observed suggest that PBMT may be a valuable adjunct to conventional therapy in treating foot drop due to peroneal nerve injury. It may enhance muscle strength, promote functional independence, and reduce disability when integrated into routine rehabilitation.

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## CONCLUSION

The study concluded that participants who received a combination of Photobiomodulation Therapy (PBMT) and Conventional Physiotherapy demonstrated greater improvements in balance, muscle strength, and functional performance compared to those who received only Conventional Physiotherapy. Although both groups showed clinical improvements following the intervention, the results were not statistically significant, likely due to the small sample size and short duration of the treatment protocol.

Furthermore, to the best of our knowledge, this is the first study to investigate the effects of PBMT using a Class IV LASER in the rehabilitation of individuals with common peroneal nerve injuries. These findings provide a foundation for future research and suggest potential benefits of integrating PBMT into conventional physiotherapeutic approaches for peripheral nerve injury rehabilitation.

## LIMITATIONS

The present study has several limitations. Firstly, the sample size was relatively small, which may limit the generalizability of the findings. Secondly, due to the short duration of the intervention, the long-term effects of Photobiomodulation Therapy could not be evaluated. Additionally, the comparison of Motor Nerve Conduction Velocity (MNCV) between the groups was not conducted due to technical difficulties. As a result, the study primarily focuses on clinical outcome measures. Nevertheless, these limitations highlight areas for future research and provide a foundation for expanding the scope of investigation in this field.

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