

Effectiveness of Sensory Stimulations in Improving Balance in Patients suffering from Peripheral Diabetic Neuropathy

Dr. Aishwarya Rai^{1*}, Shaswat Kumar Chandan², Supriyo Sarkar³, Yogakshi Banga⁴

^{1*,2,3}Assistant Professor, School of Medical and Allied Health Sciences, Brainware University

⁴Assistant Professor, MMCP&R, Maharishi Markandeshwar University, Sadopur-Ambala

DOI: <https://doi.org/10.63001/tbs.2026.v21.i02.pp163-166>

KEYWORDS

Sensory Stimulations,
Diabetic Peripheral
Neuropathy, Balance,
Vestibular training,
Proprioceptive training.

Received on: 25/02/2026

Accepted on: 23/03/2026

Published on: 09-04-2026

Abstract

Objectives: There is little study explicitly examining the efficacy of multimodal sensory stimulation Patients suffering from Peripheral Diabetic Neuropathy, despite its prevalence and associated effects on balance. In order to improve balance, this study assesses how sensory stimulations affect sensation.

Methods: An experimental study design was designed and 38 participants were gathered for the investigation. The experimental group, to which the people were randomly assigned, got mixed sensory stimulation, while the control group was given conventional care. Tests such as Berg Balance Scale were used to evaluate balance outcomes, while the Michigan Neuropathy Screening Instrument was used to evaluate sensory complaints. These evaluations were carried out both before and after the intervention.

Results: Group A and Group B's post-BBS and MNSI scores were compared using a t-test value of 0.006808 and 0.01 correspondingly. Group A and Group B's post-BBS and MNSI scores differ significantly, as indicated by these figures (0.006808, 0.01). Therefore, it can be concluded that, in comparison to Group B, the combined sensory stimulation therapies carried out in Group A had a favorable effect on both balance (BBS scores) and neuropathy (MNSI scores).

Conclusion: Therefore, based on the study's findings, we can say that multimodal sensory stimulation therapies are useful ways to help people with peripheral diabetic neuropathy become more balanced. By enhancing sensory input, proprioception, and balance control, these therapies can increase functional mobility and reduce the risk of falls.

understanding

1. INTRODUCTION

Diabetes is a common disorder that impacts up to two thirds of people with the disease. Peripheral diabetic neuropathy, which damages peripheral nerves and reduces sensation in the lower extremities, is often the result of diabetes. If peripheral nerve dysfunction is ruled out as the cause, signs and symptoms of peripheral nerve dysfunction are observed in a patient with diabetes mellitus. Hands and feet are most commonly affected. Some individuals have minor symptoms, for some, the symptoms may be painful, incapacitating, or even lethal. [1] Chronic, persistent hyperglycemia lasting several years is the typical manifestation of distal polyneuropathy. On the other hand, patients diagnosed with poor glycemic control due to type 2 diabetes mellitus may exhibit distal polyneuropathy a few years later; in few cases, these patients already had neuropathy at the time of diagnosis. [1, 3] Peripheral nerve damage can be brought on by alterations in the myelin protein brought on by advanced glycation end products. This can produce segmental demyelination of the peripheral nerves, which impairs nerve perfusion. DPN is a type of common neuropathy that mostly affects the hands and feet in the distal extremities. Clinically, the primary involvement of senses advances from the distal to the proximal regions. About thirty percent of diabetics who are

forty years of age or older experience decreased sensation, particularly in their feet. [2] Patients with neuropathies have a lower quality of life (QOL). [1, 2] In neuropathic patients, balance is improved by exercise, sensory integration and P-DTR they address problems at the level of the brain and its sensory receptors, which eventually improves sensation in the neuropathic part. [2, 6, 7] Reduced proprioception and light touch are brought on by large fiber involvement in the nerve. Perception, vibration, pressure, pain, and warmth are all involved in small fiber offense. Postural instability in diabetics is mostly caused by decreased sensory perception [1,3,4] Autonomic and neuromuscular problems are linked to an increased risk of foot ulceration brought on by trauma or repetitive loading of the plantar surface of the foot, all of which are linked to sensory loss in the diabetic limb. [4] It involves decreased feelings in the lower extremities, which reduces dynamic stability, balance, and postural control. [5] Some studies also stated that Diabetes-related neuropathy reduces postural control, which increases the risk of falls in neuropathic patients. When the vestibular system is negatively impacted by diabetes, it increases the chances of falling due to decreased balance. [6,7] The most popular and reliable tool for evaluating balance performance is the BBS. The goal of the research is to improve balance in distal diabetic neuropathy patients by

developing effective rehabilitation and offering appropriate combinations of sensory stimulations.

2.METHODOLOGY

An experimental study was conducted and the sample purposively chosen. The subjects chosen for the study were all diagnosed with distal diabetic neuropathies. The patient or the patient's proxies were informed about the study's objectives. Every participant provided their informed consent. The investigator evaluated each subject using a standard assessment form along with other assessment instruments. Sample size calculation was done by using 'staculator'. The total number of subjects was $n = 38[3]$, where male and female ratio is 20:12 respectively. Two groups of patients were formed; Group _A': patient in group a receives both proprioceptive and vestibular training as well as tactile stimulations. In this group proprioceptive training also includes P-DTR. Group _B': patients that were in the group b receives only conventional training (proprioceptive and vestibular training). Duration of the study was one year. Treatment intervention was given for five weeks to each patient. The subjects were assessed before the start of the treatment, which was marked day 0. Patients were also assessed on 35th day (post-treatment) using Michigan Neuropathy Screening Inventory; BBS in the respective days were recorded. The inclusion and exclusion criteria were followed in the selection of the participants. Consent was obtained once the individual, their family members, or a proxy were fully informed about the study's goal and methodology. Also all the participants included in the study are recruited based on their medical diagnosis or history confirming there dm, patients are added to the study after taking their consent and are divided into the experimental and control group randomly by just asking the participants to pick up the chits (experimental in one and conventional training i.e. Proprioceptive and vestibular training in other), so based on patient's selected chits they are randomly added to respective group. Selection Criteria: Inclusion Criteria: Patient with diabetic neuropathy having altered foot sensation (acc. To staging stage n2b or less). Age group 35-65 years. Both male and female. Ability to walk independently (Acc. To Berg Balance Scale Score). Exclusion Criteria: Patients with neuropathy other than diabetic peripheral neuropathy. Severe visual impairment or vision loss. Ulcer or skin infections on planter aspect of foot. Lower limb cellulitis (below knee). Any skin disorders of lower limb (below knee). Muscular weakness: grade less than 3/5 (MMT).

3.PROCEDURE

This Based on inclusion and exclusion criteria, participants were chosen for this study and split into two groups: Group A and Group B.

Group B were continue receiving standard care i.e., proprioceptive and vestibular training (stretching exercises, sit-to-stand postures, heel and toe standing, standing weight shifts, single-limb stances, stair climbing, ramp walking, spot marching, and tandem walking).

Group (A) was given combined sensory stimulation. Stimulations in the form of Tactile Stimulation, Proprioceptive Stimulation, and Vestibular Stimulation and were given for 8 weeks. Sessions was given as 4 times/ week and each session of 60 min.

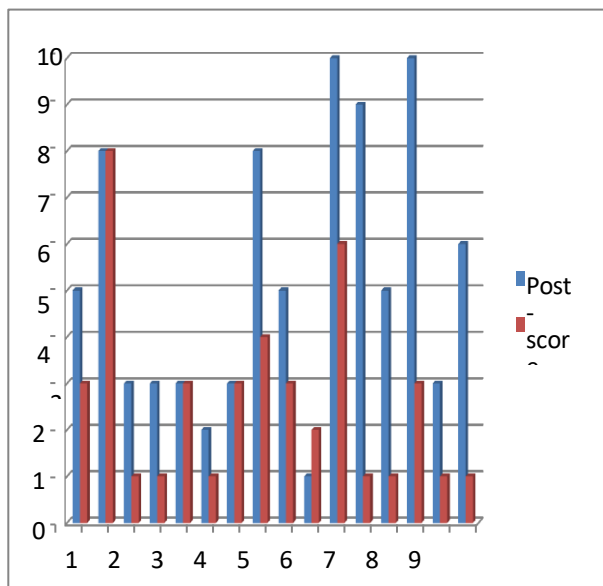
Mode of Stimulations in Group A:

- Tactile stimulations are given using Velcro straps, Camel brush and finger pulp. Finger frictions using finger pulp are effective method of tactile stimulations.
- Proprioception is facilitated by exercises such as bilateral heel rise, bilateral toe raise, spot march, and stretch reflex (P-DTR).

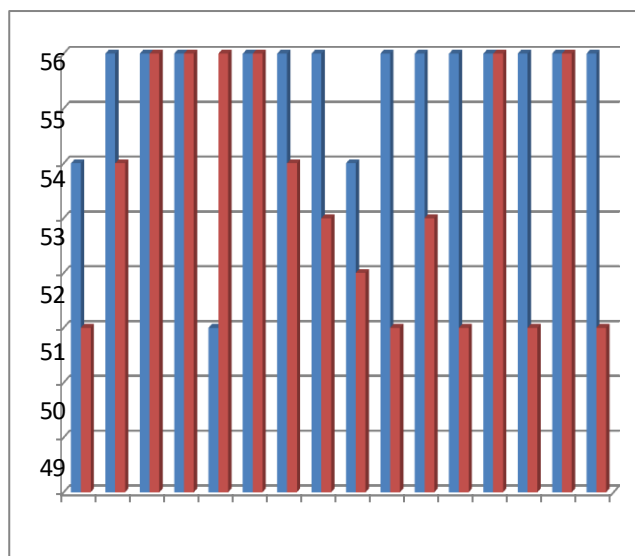
- Vestibular stimulation is facilitated by exercise with head movements during sitting and walking, double and single limb stance, Tandem stance and tandem walking, walking forwards and backwards.

Tactile Stimulations (Textures like Velcro, camel brush, and Finger pulp) are given in distal to proximal direction over foot. Progression was made weekly.

4.RESULTS AND DISCUSSION



Graph 1: Showing Post scores of MNSI for Group A and Group B



Graph 2: Showing Post scores of BBS for Group A and Group B

GROUP A & B	N	t test value	p value
MNSI	16	0.01	< 0.05
BBS	16	0.006808	< 0.05

*** shows a significant difference at 0.05 level of significance for post BBS and MNSI score i.e., $p < 0.05$

5. DISCUSSION

The purpose of this study was to provide evidence that combined sensory stimulations can help in the process of regaining sensory functions and therefore help to improve balance in diabetic neuropathy patients. Till now, no studies have demonstrated the efficacy of combined sensory stimulation in improving balance in individuals with peripheral diabetic neuropathy. Peripheral neuropathy is a nerve-related illness that causes sensory loss and muscle weakness in the extremities, notably the legs and feet. This can have a substantial impact on a person's ability to maintain balance, increasing the danger of falling. [5, 7] Sensory stimulation is activating sensory pathways to improve the interaction between sensory receptors and the brain. This can be accomplished using a variety of methods, including proprioception training, and balance exercises. In neuropathic patients, balance is improved by exercise and sensory integration. [2, 6, 7] Before starting the procedure the BBS and MNSI scores of the patients undergoing the therapy was recorded, and the same was done after the termination of the treatment. Each patient underwent for treatment i.e. sensory stimulation programme, maximum of 1.5 hours daily. Post this, all patients were given follow-up sessions every week for 1 month. Periodic follow-ups ensured that the patients followed the home protocol. The patients involved in the study had little to no side effects to combined sensory stimulations, none of which had an impact over the study.

The final BBS and MNSI scores were taken on the last day of the treatment. The pre and post values of BBS and MNSI were recorded. Mean and standard deviation values for pre and post BBS and MNSI were calculated for each group and a comparison between both the groups was done as well. An unpaired t-test was calculated to record a significant difference in the post BBS and MNSI values was also performed. A total of 38 patients with T2D were contacted; however 6 did not complete the assessment. Therefore, 32 participants (20 Males and 12 Females) were enrolled. In our study it was noted that patients who received combined sensory stimulations showed better results (Group A) compared to patients that did not receive combined sensory stimulations (Group B). Patients of group A were asked to wear textured insoles and perform STM on their feet each day.

Mehta et al. in his research, he found that plantar tactile stimulation helped diabetic peripheral neuropathy patients with their balance, movement, and fall prevention. [4] Maruboyina et.al. (2019) in her article concluded that patients who received Sensory Specific Stimulations have significant effect in improving balance to those who received Conventional Exercise alone.[3] Proprioception training mainly aims to increase the body's awareness of its position and movement in space. This can be accomplished by activities that require balance and stability, such as standing on one leg or using unstable surfaces. Patients who challenge their body proprioception can increase in their

capacity to improve balance and reduce their chance of falling. [8]

Combined sensory stimulation has showed efficacy in improving balance in people with peripheral diabetic neuropathy. Combining sensory stimulation approaches, such as tactile stimulation and proprioception training along with balance training, can enhance balance in patients with peripheral diabetic neuropathy. By targeting numerous sensory pathways, these therapies can boost the sensory input to the brain and improve the integration of sensory information for better balance control. This study reported improvements in sensory and balance control.

Treatment strategies should be created in cooperation with other healthcare professionals or qualified physical therapists to better outcomes. To understand the therapeutic advantages of sensory-specific therapies in individuals with diabetic neuropathic pain, more research is required. Additional research and more no. of sample studies are needed to investigate the long-term effects and best approaches for combined sensory stimulation in this patient population. Nonetheless, current data supports the use of combined sensory stimulation as an effective supplementary treatment for balance abnormalities caused by peripheral diabetic neuropathy. The findings of this research will contribute to the existing body of knowledge regarding the management of balance impairments in individuals with PDN. This treatment approach is inexpensive, well tolerated and can be easily instilled in the rehabilitation methods in society especially a developing one such as in India.

6. CONCLUSION

In conclusion, combined sensory stimulation treatments, such as tactile stimulations, Vestibular training and proprioception training, have been proven to improve balance in individuals with peripheral diabetic neuropathy. These therapies can improve sensory input, proprioception, and balance control, lowering the risk of falls and increasing functional mobility. Treatment strategies should be created in cooperation with other healthcare professionals or qualified physical therapists to better outcomes. Nonetheless, current data supports the use of combined sensory stimulation as an effective supplementary treatment for balance abnormalities caused by peripheral diabetic neuropathy. The findings of this research will contribute to the existing body of knowledge regarding the management of balance impairments in individuals with PDN. This treatment approach is inexpensive, well tolerated and can be easily instilled in the rehabilitation methods in society especially a developing one such as in India.

Limitations of study: The scope of study was limited due to lack of a long-term follow-up. It was also limited because it was restricted to a specific age group. The study only included patients with distal symmetric polyneuropathy; although, there are other forms of DN and their associated symptoms. Due to a limited time, this study was conducted on a small number of patients.

Recommendations: In further studies, it is suggested that the treatment follow-up at regular intervals must be done to get better understanding regarding prognosis related to treatment. To understand the therapeutic advantages of sensory-specific therapies in individuals with diabetic neuropathic pain, more research is required. Studies should also be done in geriatric patients to get the result of combined stimulation on balance in geriatric category. Randomised controlled trials should be conducted in future studies to evaluate the effectiveness of combined sensory stimulations in improving balance in diabetic peripheral neuropathy patients. The study should include all diabetic neuropathy patients of all ages.

7. REFERENCES

- Dianna Quan, Romesh Khardori, Neil A Busis, Diabetic Neuropathy, *Endocrinology Medscape*; Aug 24, 2021; 14(4):435-446.
- Dr. Prachi S. Jain, Dr. Suraj, B. Kanas Effectiveness of Sensory-Motor Integration in Diabetic Polyneuropathy, June 2020; 19(0); ISSN: 2320-0693.
- Sowjanya Maruboyina Significance of Sensory Specific Intervention on Balance in Type 2 Peripheral Diabetic Neuropathy Individuals, *International Journal of Health Sciences & Research*, April 2019; 9 (4): 2090-2098.
- Shailendra Kumar Mehta A comparative study to evaluate effect of planter tactile stimulation versus foot insoles to improve balance, mobility and reduce fall in diabetic peripheral neuropathy, *International Journal of Orthopedics Sciences* 2020; 6(1): 1195-1199.
- Giri, H. S., & Borkar, P. Effects of sensory stimulation on balance and postural control in diabetic neuropathy: systematic review. *International Journal of Research in Medical Sciences*, 9(7), 2090-2098. <https://doi.org/10.18203/2320-6012.ijrms20212531>.
- Kalisch T, Tegenthoff M, Dinse HR. Improvement of sensorimotor functions in old age by passive sensory stimulation. *Clin Interv Aging*. 2008;3(4):673-90; doi: 10.2147/cia.s3174. PMID: 19281060; PMCID: PMC2682400.
- Rashmi Pathak, Neetu Sachan, Phool Chandra, Mechanistic approach towards diabetic neuropathy screening techniques and future challenges: A review, *Biomedicine & Pharmacotherapy*, Volume150, 2022: 113025; ISSN0753-3322.
- Mahdieh Ravand Dynamic balance and neuropathic changes following ankle proprioceptive training in type II diabetic patients with peripheral neuropathy, *Iranian Red Crescent Medical Journal* 23 (5), 2021; doi: 10.32592/ircmj.2021.23.5.406.