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Proprioceptive training's impact on postural stability in diabetic neuropathy individuals

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Abstract
Background: The improvement of proprioceptive function is the goal of proprioceptive training. When information from other modalities, like vision, is unavailable, it emphasizes the use of somatosensory signals, such as tactile or proprioceptive afferents. Controlling one's body position in space for the sake of movement and balance is known as postural stability. People who have diabetes may develop diabetic neuropathy, which is damage to the nerves. The symptoms of various nerve damage types vary.
Goal: To ascertain how proprioception training affects diabetic neuropathy patients' ability to balance.
Method: Two groups of 30 subjects each will be formed from a total of 60 subjects with type 2 diabetic peripheral neuropathy.
Results: The exercise group included 30 (50%) of the 38 patients, with a mean age of 64±7.7 years; 16 (52.6%) were male and 14 (47.3%) were female. The control group had 30(50%) patients with a mean age of 64±8.2 years; 18(63.1%) males and 12(36.8%) females. When the eyes were open, the one leg standing score improved significantly ($p<0.05$), but when the eyes were closed, the difference was not significant. The exercise group's timed-up and go scores and Berg balance scale showed significant improvement ($p<0.05$).
Conclusion: Patients with diabetic neuropathy reported better balance after engaging in proprioception training exercises.

Keywords: Diabetic neuropathy, proprioception, postural stability, dynamic balance, static balance

Introductions

Proprioceptive Training

A technique for enhancing proprioceptive function is called proprioceptive training. It focuses on using somatosensory signals, like tactile or proprioceptive afferents, when information from other modalities, like vision, is not available. Eventually, it aims to restore or enhance sensorimotor function. We used the aforementioned definition to perform a systematic review on the efficacy of proprioceptive training because the term has been used extensively and claims of enhanced proprioception through particular interventions are frequently found in the literature. It has been suggested that proprioceptive training should be the main focus of therapies meant to restore motor function following injury because proprioception is crucial for motor control. There are many interventions that claim to be a type of proprioceptive training that helps with motor recovery and enhances proprioception. Sadly, there is not much consensus on what exactly qualifies as proprioceptive training. This could be partly because the term "proprioception" has multiple definitions.

Postural stability

The orientation of the body in particular positions is commonly referred to as posture (Rosário, 2014). Either in motion or in stillness, it can be described. According to Woollacott and Shumway-Cook (2002), postural stability is the capacity to regulate one's body's position in space for the purposes of movement and balance. It helps with body coordination during dynamic position changes and is essential for maintaining a static position. Long-term bad posture can lead to musculoskeletal problems.

Diabetic neuropathy

Diabetes patients frequently experience polyneuropathy, which impairs limb sensation and movement and causes pain. Because diabetic neuropathy patients frequently have balance issues, it is a major contributing factor to falls. Postural sway in those patients is increased, especially with the eyes closed.

Diabetic neuropathy can be divided into two categories

Neuropathy, both peripheral and autonomic Diabetes-related peripheral neuropathy severely impairs foot sensation, making it harder for patients to maintain proper balance while engaging in daily activities. Impaired proprioception, movement-strategy dysfunction, biomechanical structural disorders, and disorientation are all contributing factors to poor balance. Consequently, peripheral neuropathy-induced postural instability exacerbates the effects of wounds and microtraumas.

Damage to the nerves that regulate your internal organs, such as the digestive tract, bladder, sex organs, sweat glands, eyes, and heart rate and blood pressure, is known as autonomic neuropathy. Additionally, hypoglycemia unawareness may result from the damage.

People with diabetes frequently suffer from polyneuropathy, which causes pain and impairs limb sensation and movement. People with diabetic neuropathy are more likely to fall because they frequently have balance issues. Those patients exhibit more postural sway, particularly when their eyes are closed. Diabetes-related peripheral neuropathy severely impairs foot sensation, making it harder for patients to maintain proper balance while engaging in daily activities. Disorientation, biomechanical structural disorders, movement strategy dysfunction, and proprioception impairment are all contributing factors to poor balance. Therefore, the impact of microtraumas and wounds is increased by postural instability brought on by peripheral neuropathy. When it comes to maintaining body balance during both silent stance and unanticipated postural changes, proprioception is crucial. As a result, standing with their eyes closed makes people with peripheral neuropathy unsteady. In comparison to healthy control subjects, numerous authors have discovered that people with peripheral neuropathy and diabetes exhibit poorer postural control when standing quietly. According to Boucher and colleagues, compared to healthy control subjects, people with diabetes and peripheral neuropathy had more postural sway when standing quietly and had more trouble integrating sensory information for balance control. They also mentioned that the degree of peripheral neuropathy was correlated with postural control. Furthermore, Lafond and colleagues discovered that postural sway in elderly people with peripheral neuropathy and diabetes who had their eyes open was similar to that of healthy elderly people who had their eyes closed. The impact of diabetic peripheral neuropathy on postural control was the main focus of these investigations. The present study aimed to evaluate the impact of proprioceptive training on functional balance and balance indices during bipedal stance with eyes closed in patients with diabetic neuropathy.

Objectives

The purpose of this study is to assess the effectiveness of proprioceptive training on postural stability in subjects with diabetic neuropathy.

- To assess the stability of posture in individuals suffering from diabetic neuropathy.
- To determine the kind of neuropathy that patients have
- To determine whether proprioceptive training is beneficial for individuals with diabetic neuropathy.

Hypothesis

Null hypothesis

The effects of proprioceptive training exercises in conjunction with traditional physiotherapy and traditional physiotherapy alone on postural stability in patients with type 2 diabetic neuropathy will not differ significantly.

Alternative hypothesis

The impact of proprioceptive training exercises in conjunction with traditional physiotherapy versus traditional physiotherapy alone on postural stability in patients with type 2 diabetic peripheral neuropathy will differ significantly.

Significance of the study

It will be a significant improvement in the rate at which patients with diabetic neuropathy recover. As a result, it will slow the progression of diabetic neuropathy.

Methodology

Study Design: The Study Design Is A Pre And Post-Test Experimental Study Design.
Study Duration: The Study Duration Is Three Month.
Sample Design: Purposive Sampling.
Sample Size: The Total Of 60 Subjects With Type 2 Diabetic Peripheral Neuropathy Will Be Assigned In Two Groups, With 30 Subjects In Each Group.
Sample Collection Method: Judgemental Sampling

Subject selection criteria

Inclusion criteria

Age 50-60 years, type 2 diabetic peripheral neuropathy, Both gender (male and female), Able to make unipedal stance for 20 seconds, Ability to complete 2-minute walk, Strength of both lower limb muscles at least MRC grade.

Exclusion criteria

Patients with vestibular dysfunction, central nervous system dysfunction, musculoskeletal deformity, cardiovascular problems, planter ulcers, and visual defects.

Outcome measures

Dynamic gait index, Berg-balance scale.

Variables

Dependent variables: Gait, Balance
Independent variables: Proprioceptive training, Conventional physiotherapy

Data collection procedure

- Procedure will be explain to the all patients consent form will be signed from the patient.
- Identify the dependent variable in the patients.
- Evaluate the static postural stability of patients with help of BBS.
- Evaluate the dynamic postural stability of patients with help of dynamic gait index.

- Each patient is treated for 4 days a week for 4 weeks each therapy session lasting for about 45 minutes.

Outcome measures

The Berg Balance Scale (BBS) was used to measure functional balance both before and after the intervention. It is a valid and reliable scale including 14 functional tests, which can quantitatively evaluate balance in community-dwelling adults and patients with balance disorders. The Berg Balance Scale takes 10 to 20 minutes to complete, and the result indicates how well the person can control their postural balance. Patients' eligibility was evaluated. (n=82) Exclusion (n=12) for not meeting inclusion criteria 60 patients met the inclusion criteria Patients randomly allocated (n=30) Proprioceptive training group (n=30) Conventional physiotherapy + proprioceptive training. Each test is scored 0-4 (0 – inability to complete the task; 4 – independent task fulfillment). Each test's total score is the sum of its individual scores. As a result, the lowest possible total score is zero, and the highest is 56. A higher score denotes a better balance of functions. Numerous studies have demonstrated the high test-retest, intra-rater, and inter-rater reliability of BBS.

Equipment required: A ruler, 2 standard chairs (one with arm rests, one without), A footstool or step, 15 ft walkway, Stopwatch or wristwatch

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Procedure

For eight weeks, the intervention was given twice a week. Control group: Traditional physiotherapy care For 45 minutes, 30 was administered, with a one-minute break in between each five-minute workout. The following exercises were part of the program: Deep breathing exercises for relaxation (3 minutes), bilateral ankle range-of-motion exercises (5 minutes), and functional balance training (15 minutes) with sit-to-stand and standing weight shift (5 times each) as well as functional reach-sideways and anterior for Touching the therapist's designated targets five times each; bipedal heel rise five times each; 15 seconds of unipedal standing five times each; and 15 seconds of unipedal standing with knee bending five times each. Additional exercises included gait training, which included tandem walking (5 minutes) and spot marching (5 minutes), as well as wobble board training (6 minutes).

Proprioceptive training group

In addition to 26 minutes of proprioceptive training (one minute of rest for every six minutes of exercise), the control group received the same standard physiotherapy. According to Santos *et al.* [22], the protocol comprised a circuit with various floor textures made up of 13 exercise stations designed to stimulate the sole of the foot. Participants were required to coordinate their gait by stepping with alternate feet on ground markers, and the progression was adjusted by changing the speed and direction. Each station's activity lasted two minutes, and the slow- and fast-paced music alternated to set the exercise rhythm. The circuit was constructed using the following materials: foam that was 10 cm thick, a wood box filled with beans, a mat that was 2 cm thick and had a density lower than the foam, a wood box filled with cotton, and another mat that was 2 cm thick. Following that, the lateral balance reactions were trained on a balance board. Volunteers trained their foot flexors at the seventh station by sitting on a bench and using their toes to grasp a towel that had been placed on the floor. At the eighth station, there was again a ten-cm-thick foam. The next station used two proprioception balls that were eight centimeters in diameter and had external projections that rested on the floor. A box containing grains and a two-cm mat were located at the tenth and eleventh stations. Balance and hip movements were trained at the 12th station with medicine balls (diameter 75cm). The patients had to alternately slide their feet on sandpaper that was spread out on the ground at the final station.

Statistical analysis

The Graphpad Statemate 2.0 program was used to determine the sample size (Power test). For calculations, the estimated sample size was 14 patients, and the means and standard deviations of the balance indices were taken from a pilot study with a power of 80% and $\alpha = 0.05$. SPSS version 17.0 was used to perform the statistical analyses (SPSS, Inc., Chicago, IL). The Kolmogorov-Smirnov (KS) test was used to determine whether the data was normal for each statistical variable, and the results validated the use of parametric tests.

Results

Every patient consented to the use of their training data and completed the training without any issues. Assessments of the data distribution were found to be normal by the Kolmogorov-Smirnov analysis of normality. There were no baseline differences between the two groups in terms of demographic and descriptive traits (table 1). Similarly, prior to the intervention, no discernible variations were observed in the parameters under investigation (table 3).

BBS scores

There was a noteworthy rise in BBS scores for both the control group (P=0.021) and the training group for proprioception (P=0.0001) (Table 2). Furthermore, following treatment, the effect size (d=.8) between the two groups showed a significant magnitude difference. DGI scores: notable alterations were discovered.

The exercise group included 30 (50%) of the 38 patients, with a mean age of 64±7.7 years; 16 (52.6%) were male and 14 (47.3%) were female. The control group had 30(50%) patients with a mean age of 64±8.2 years; 18(63.1%) males and 12(36.8%) females. When the eyes were open, the one leg standing score improved significantly ($p<0.05$), but when the eyes were closed, the difference was not significant. The exercise group's timed-up and go scores and Berg balance scale showed significant improvement ($p<0.05$).

Table 1: Berg Balance scale scoring for Group A

Outcome measure	Test	Mean	Standard deviation (SD)	Calculated 't' value	P value
Berg Balance scale	**Pretest**	32.87	2.26	20.46	<0.0001

Table 2: Berg Balance scale scoring for Group B

Outcome measure	Test	Mean	Standard deviation (SD)	Calculated 't' value	P value
Berg Balance scale	Pretest	33.0	2.24	13.884	<0.0001
	Posttest	37.47	1.85		

Table 3: Dynamic gait index scoring for Group A

Outcome measure	Test	Mean	Standard deviation (SD)	Calculated 't' value	Pvalue
Dynamic Gait Index	Pretest	18.80	0.77		
	Posttest	23.47	0.52	20.088	<0.0001

TherewasasignificantdifferenceintheDynamicGaitIndexofexperimental training group at the level 0.05% at 14 degrees of freedom

Table 4: Dynamic Gait Index Scoring for Group 2

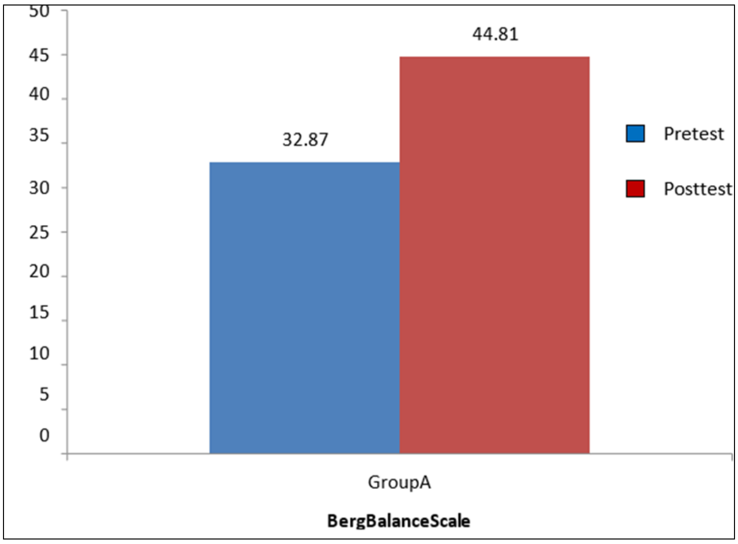
Outcome measure	Test	Mean	Standard deviation (SD)	Calculated 't' value	P value
DGIS	Pretest	18.67	0.72	7.2457	<0.0001
	Posttest	20.67	0.90		

There was a significant difference in the Dynamic gait index scale of Group Bat the level 0.05% at 14 degrees of freedom.

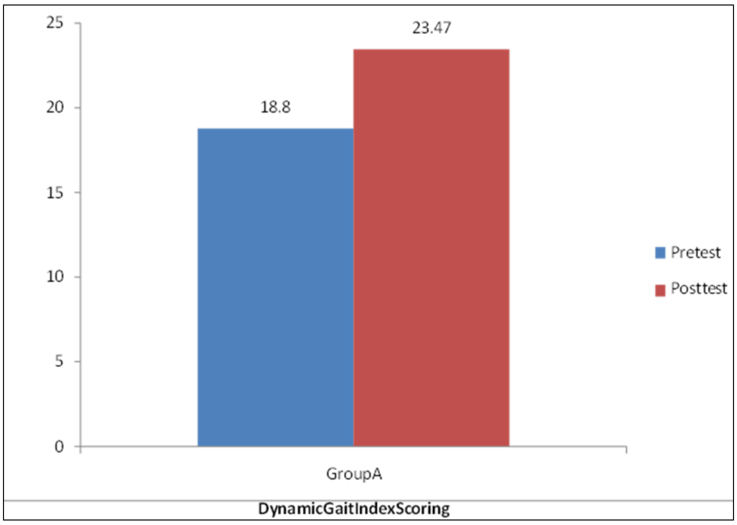
Table 5: Comparison of Berg balance scale and Dynamic Gait Index in both the groups

Outcome measure	Groups	Mean	Standard deviation (SD)	Calculated't' value	P value
Berg Balance scale	Group A	44.81	3.76	6.495	<0.0001
	Group B	37.47	2.24		
Dynamic gait index	Group A	23.47	0.52	10.433	<0.0001
	Group B	20.67	0.90		

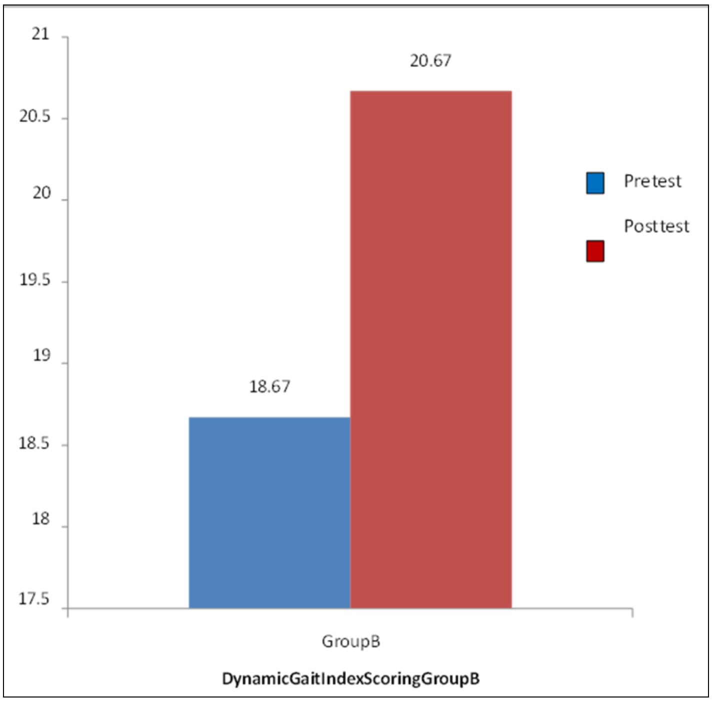
ThereWasasignificantdifferenceintheinExperimentalgroupandcontrol group at the level 0.05% at 28 degrees of freedom.



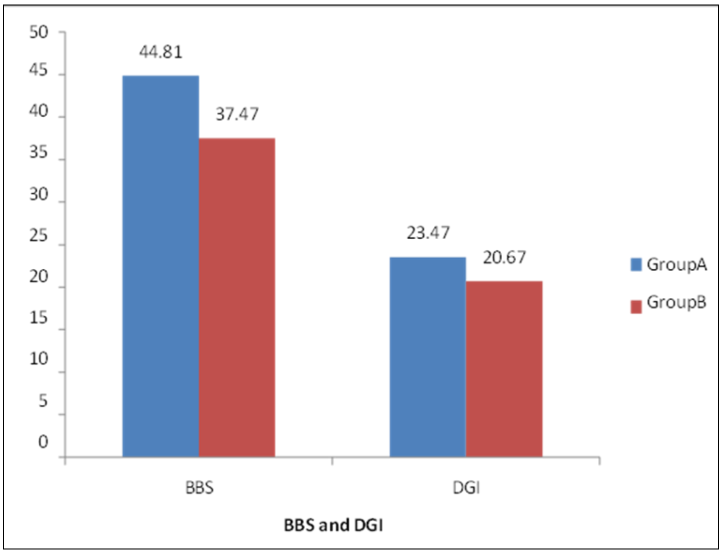
Graph 1: Berg balance scale for group 1



Graph 2: Berg balance scale scoring for group 2



Graph 3: Dynamic gait index scoring for Group A



Graph 4: Comparison of Berg Balance Scale and Dynamic Gait Index in both the groups

Discussion

The Berg balance scale (BBS) and dynamic gait index (DGI) were used to measure the patients' gait and balance. A statistical analysis revealed a significant difference between the pre and post scores. The DGI readings changed after four weeks, according to the post-test results, but the experimental group's BBS scores only slightly differed, suggesting that the improvement in balance persisted even after the post-treatment period. Nevertheless, there was no discernible difference between the BBS post-test and follow-up readings. Proprioception is a factor often impaired in diabetic neuropathy, which can result in decreased balance, a higher chance of falling, and consequently a fear of falling. Therefore, it is crucial to concentrate on enhancing balance in order to lower the frequency of falls and injuries. This study concentrated on DPN patients' gait and balance, which can be enhanced by balance training on a stability trainer and lowers the risk of falls. Ajimsha *et al*. (2011) found that stability trainers are useful for improving static balance in patients with distal sensory diabetic neuropathy, which corroborated the findings of the current study. Shah and Jayavant's (2006) study on ambulatory hemiplegic patients revealed that using a stability trainer with varying postures and suitable challenge levels helps these patients' balance. When standing on a stability trainer, somatosensory training can also enhance the increased proprioceptive firing from the cutaneous receptors on the feet and the muscle mechanoreceptors during co-contraction caused by the swaying movements. Because practicing balance training at increasingly difficult levels is indicative of its potential to enhance somatosensory integration with visual and vestibular senses in the central nervous system, the experimental group may have improved more than the control group. A stability trainer presents an unstable surface that tests the body's ability to stay balanced. During the exercise intervention with stability trainer, sensory inputs could be manipulated by altering the support surfaces and environments**.** The study's main conclusion was that proprioceptive training in conjunction with traditional physiotherapy was noticeably more successful than traditional physiotherapy alone in improving patients with diabetic polyneuropathy's functional balance as determined by the BBS and their balance indices (OASI, APSI, and MLSI) as determined by the Biodex balance system. The study's shortcomings included the inability to blind trial practitioners and the lack of long-term participant follow-up. In diabetes mellitus, distal sensorimotor polyneuropathy (DPN) is one of the most prevalent consequences. Up to 50% of elderly diabetic patients with a history of diabetes lasting more than 25 years have DPN, which impairs the somatosensory system, a crucial sensory system involved in human postural control, and causes a distal to proximal deterioration of the nervous system in the lower extremities. Postural instability in DPN patients has been caused by a lack of accurate proprioceptive information from the lower extremities in a variety of static and dynamic situations, particularly when the body is subjected to unexpected postural perturbations. As a result, those patients are particularly vulnerable to falls, which could have fatal outcomes. The results of this study are consistent with those of other investigations that examined the impact of proprioceptive exercise regimens on diabetic patients. They reported that falls linked to sensory deficiencies can be decreased by improving balance and postural stability, most likely through an increase in peripheral afference. Any changes in one or more of these systems, such as sensory deficiencies in the feet, can lead to postural instability. Postural control is the outcome of the interaction of the vestibular, visual, and sensory systems. The multisensory stimulation offered by the intervention may have contributed to the decrease in OASI, APSI, and MLSI indices seen in this study following the training regimen. According to the study, practicing balance training at increasingly difficult levels can improve somatosensory integration, which may explain why the proprioceptive training group improved more than the control group. Furthermore, pro-priocetive training presents an unstable surface that tests the body's ability to maintain equilibrium. By changing the support surface, sensory inputs were controlled during the exercise intervention. Participants were effectively forced to reweigh the remaining inputs within the CNS36 as a result of these manipulations. Previous studies have shown improved stability when manipulating the proprioceptive or vestibular environment, indicating similarly enhanced central integration after sensory training. Additionally, during co-contraction caused by the swaying movement, proprioceptive training can enhance increased proprioceptive firing from both the mechanoreceptors of the muscle and the cutaneous receptors from the feet. Additionally, it is possible that the improved motor learning brought about by the new and enhanced feedback will also affect balance. Last but not least, proprioceptive training is a straightforward and affordable therapeutic approach for enhancing functional balance in diabetic neuropathic patients. This may lower the patient's risk of falling while engaging in everyday activities, thus improving their quality of life.

Conclusion

In diabetic neuropathy, proprioceptive training in conjunction with traditional physiotherapy was more successful than traditional physiotherapy by itself at enhancing functional balance and lowering balance indices.

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