

Effectiveness of Functional Strength Training and Balance Training on Postural Stability and Gait in Patients with Diabetic Peripheral Neuropathy to Reduce the Risk of Falls

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ABSTRACT

BACKGROUND: Diabetic peripheral Neuropathy (DPN) is one of the most common chronic complications of diabetes mellitus, mainly affects lower limbs in patients with diabetes. It may lead to distressing and expensive clinical sequelae like impairments in tactile sensitivity, vibration sense, lower limb proprioception, and kinesthesia. This lead to the increased risk of falls. Thus, taking into consideration, the debilitating effects of diabetic neuropathy, Functional strength training (ST) and Balance training is advocated for these individuals to prevent further deterioration

AIM: The objective of this study was to study the effectiveness of functional ST and balance training on Postural stability and gait in patients with diabetic neuropathy.

Methodology: This study was an experimental study and type of sampling was convenient sampling. The Sample size taken was 20 and the place of the study conducted was physiotherapy OPD.

Results: The results were obtained using BBS, DGI and ABC scale on the basis of pre and post treatment data were collected. Statistical Analysis shows the positive effectiveness of Functional strength training and balance training on reducing the risk of falls in Diabetic peripheral neuropathy

Conclusion: Functional strength training and Balance training can be included as a part of treatment for patients with Diabetic peripheral neuropathy.

Keywords: Diabetic peripheral neuropathy, Functional strength training, Balance

INTRODUCTION

Diabetic peripheral neuropathy is the most common neuropathy in developed countries. Diabetes is a rapidly growing health challenge and potential epidemic across the low and middle income countries like India. With more than 62 million diabetic individuals currently diagnosed with the disease. [1] India ranks second after China in the global diabetes epidemic with 77 million people with diabetes. According to the CDC, 463 million adults have diabetes worldwide .The prevalence of diabetes in urban areas being higher than rural areas, being highest in the age group of 55–64 years .This is primarily due to dietary transitions and insufficient or lack of physical activity altering the physiological milieu leading to overweight or obesity and Diabetes. [2][3] Approximately 50 percent of patients with diabetes will eventually develop neuropathy. DPN is a leading cause for disability due to foot ulceration and amputation, gait disturbance, and fall-related injury. Diabetic Neuropathy is a “symmetrical, length-dependent sensori motor polyneuropathy attributable to metabolic and micro vessel alterations as a result of Sensory symptoms start in the toes and over time affect the upper limbs. Diabetic peripheral neuropathy (DPN) may lead to muscle weakness, loss of ankle reflexes, and impairment in balance, coordination and gait control which significantly increase the risk of falling

and sustaining fall-related injuries.[4][5][6] Both sensorimotor function and cognitive processes such as fear of falling contribute to fall risk. Higher rate of alterations in balance and gait are seen in DPN patients. Falls in people with diabetes are a major problem, with feelings of unsteadiness, associated psycho social effects and direct physical consequences.[7] Sensory and Motor neuropathy affecting the foot and Lower limb are major contributory factors to gait impairments, subsequent unsteadiness and increased fall risk. The fear of falling leads to restriction of activities of daily living within their capabilities and decline in mobility and in reducing physical activities levels which is a particularly undesired consequence for people with diabetes when physical activity plays a major role in helping to regulate glycaemic control. Marked unsteadiness was only evident in patients with moderate to severe diabetic peripheral neuropathy. [8] Diabetic peripheral neuropathy is a major contributory factor for unsteadiness and heightened falls risk. Slower and impaired – limb muscle responses evident during gait may also be caused by motor impairment in people with diabetic peripheral neuropathy. Diabetic peripheral neuropathy is associated with a slowing of motor neuron conduction velocity and weakness, particularly of more distal lower-limb muscles. Diabetic peripheral neuropathy is most common complication in 60% of elderly diabetics, leading to the decreased sensitivity of proprioceptive and vestibular function, slower reaction times, and greater postural instability and altered walking patterns, which could contribute to an increased risk of falling, reduced quality of life and even increased mortality rate. [9] Appropriate balance training could improve balance in elderly patients with DPN and reducing the risk of falling. The precise mechanisms of exercise –induced nerve protection is, exercise is effective at restoring neurotrophin levels, reducing oxidative stress and reducing inflammation. Exercise can also prevent myelin damage

and reduce CA²⁺ channel dysfunction to improve electrophysiological function. Exercise is known to improve multiple metabolic factors that may affect nerve health and micro vascular function, which may indirectly protect against peripheral nerve damage.[10] People with diabetes may experience premature and progressive sarcopenia with low muscle quality because of excessive IMAT accumulation in ectopic sites, including key skeletal muscles. Lower extremity skeletal muscles of people with DPN accumulate excessive volumes of IMAT, with concomitant decreases in muscle volume in the intrinsic and extrinsic muscles. Reduced gait speed, increased stance time, decreased Cadence, short stride length, and higher variability in step Lengths as compared to healthy individuals of the foot Weakness in the lower limb muscles leads to an increase in postural sway in standing which further manifolds the fall risk. The strengthening for lower limbs in functional positions in diabetic neuropathy may lead to faster foot reaction time to visual stimuli, improved leg strength, less sway, and a reduced risk of fall. Interventions of balance training and lower extremity strengthening have been shown to have a small positive effect on the progression of PPN.

MATERIALS & METHODS

This study was done on 20 participants who were diagnosed with Diabetic polyneuropathy carried out for a period of 6 months from April 2022 to September 2022 in District Head quarters Hospital, Chittoor, Andhra Pradesh, India. The sample size of 20 were selected randomly and included in this study, the participants who met the Inclusion and exclusion criteria

The participants who scored <3 as per the the Michigan Neuropathy Screening Instrument (MNSI) were chosen for the study. Other inclusion Criteria of the study were as follows:(i)Diagnosed with type II diabetes,(ii) Both males and females between the age group of 50-65 years ,(iii) Duration of diabetes more than

5years(iv)Minimum grade 3 strength in lower limbs according to Medical research grading (v) Able to stand and walk without assistance (Vi)subjects with berg balance score of low and medium risk. We excluded the participants who had any of the following:(i)with peripheral vascular diseases (ii)Musculoskeletal disorders affecting lower limbs (iii)common peroneal nerve injury (iv) with Visual and vestibular impairments (v) with severe diabetic foot ulcers (vi) diagnosed with other neurological disorders.

Procedure:

Participants diagnosed with diabetic peripheral neuropathy between the age group of 50-65 years were screened using the inclusion and exclusion criteria. Written informed consent was obtained from all the participants by explaining the study process. Outcome measures used to assess were Berg Balance Scale (BBS) and gait using Dynamic Gait Index (DGI), 16 Item Activity Specific Balance Confidence (ABC) scale to assess participants confidence in performing daily routine activities without losing their balance .The scores of the scales (BBS, DGI & ABC) were compared at baseline and after intervention.

Procedure For Outcome Assessment:

This is an efficient measure of postural balance in older adults. The BBS is a qualitative measure that assesses balance via performing functional activities such as reaching, bending, transferring, and standing that incorporates most components of postural control. The BBS consists of 14 items scored on a 5-point ordinal scale, ranging from 0 to 4 (0 indicates lowest level of function; 4 indicates highest level of function), with a maximum total score of 56. Participants presenting a score of 41 to 56 points have been described as “independent”; scores of 21 to 40 are interpreted as “walking with assistance”; and scores of 0 to 20 are generally classified as “wheelchair bound.” BBS has got

excellent test-retest reliability with interclass correlation coefficient - 0.91 and the inter rater reliability is excellent. The DGI showed high reliability and showed evidence of concurrent validity with other balance and mobility scales. It is a useful clinical tool for evaluating dynamic balance in ambulatory people assesses individual's ability to modify balance while walking in the presence of external demands. The Dynamic Gait Index (DGI) was developed as a clinical tool to assess gait, balance and fall risk. The DGI tests the ability of the participant to maintain walking balance while responding to different task demands, through various dynamic conditions. It includes eight items; each item is scored on a scale of 0 to 3, with 3 indicating normal performance and 0 representing severe impairment. The best possible score on the DGI is a 24. High intra rater and inter rater reliability in older adults score of less than 19 indicates a risk for falling. Anything less than the maximum score of 12 on the short form identified individuals with balance deficit and those who scored less than 10 were at risk The ABC Scale is a self-report measure of balance confidence in performing various activities without losing balance or experiencing a sense of unsteadiness For falls. Activities-specific balance confidence (ABC) scale is a structured questionnaire that measures an individual's confidence during ambulatory activities. It's a 16-item questionnaire where patients' rate their confidence while doing activities. Scoring from 0-100 (0 is no confidence and 100 is full confidence), excellent overall test-retest reliability (11)

Procedure for Intervention:

This study was conducted for 5 days a week for 12 weeks on individuals with Diabetic poly neuropathy. A Brief warm up period of 5 minutes was given to the patients that included Stretching of Tendo Achilles and Hamstrings and ROM exercises for both lower limbs. The

subjects were asked to perform ten repetitions of Ankle Dorsi flexion and Plantar flexion followed by Knee flexion and Extension. Then both Hips ROM exercises including flexion and abduction were given to perform. The entire warm-up exercise sessions were performed actively by the participants.

The participants received Functional strength training for a period of 30-35 minutes per session, followed by a rest period of 10 minutes and Then Balance training for a for period of 40 minutes. The Functional Strength training includes sit to stand and Stand to sit (10 repetitions from a chair of without arm rests for 3 sets), walking up and down a ramp (6 laps), stair climbing (1 staircase-12 steps, 6 laps), and mini hops (10 repetitions).Once the patient become stronger additional weights are added. Followed by this the participants received Balance training includes

Walking Sideways (10 steps to the right and 10 steps to the left),Heel toe standing(Hold on for 10 seconds ,with support and without support),Heel Toe Walking (10 steps with support and without support, Both forward and backward),One leg stand (for both legs ,Hold on for 10 seconds ,with support and without support),Heel walking (10 steps, with support and without support),Toe walking (10 steps, with support and without support)

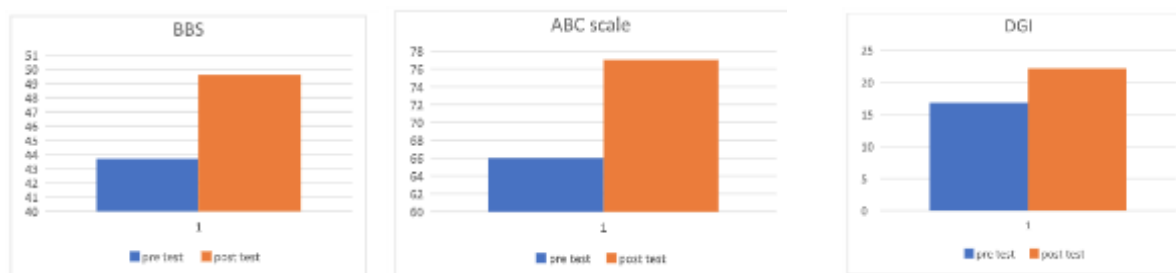
STATISTICAL ANALYSIS:

All data were analyzed using the Graph Pad In Stat version 3.06 (Graph pad software San Diego, California). Baseline characteristics such as age and duration of diabetes passed the normality test. Quantitative variables were represented by Mean \pm SD. The paired t-test was used to examine the difference between pre and post-treatment within the group

Table- 1

Study Group		Mean in %	Standard deviation	t value	Standard error of difference	P value
Berg Balance Scale	Pre -test	43.70	1.30	13.5915	0.427	<0.0001
	Post -test	49.40	1.40			
Dynamic Gait Index	Pre -test	16.80	0.77	22.3623	0.239	<0.0001
	Post -test	22.15	0.75			
Activities Specific Balance Confidence	Pre -test	66.00	6.81	5.5365	1.987	<0.0001
	Post- test	77.00	5.71			

Graphs



RESULT

The study began with an initial screening of 30 individuals, 10 were excluded based on selection criteria, and 20 were finally chosen on the basis of inclusion criteria and were enrolled in the study. All participants completed the intervention and assessments. Outcome measures including BBS, DGI,

ABC, within groups using the t-test with level of significance set at $P < 0.0001$ (paired t-test for within group comparison Table 1 presents the descriptive statistics, mean and standard deviation (SD) of dependent variables, and comparison of pre and post treatment assessment. Significant differences were found pre and after 12

weeks post-treatment assessment in all outcome measures at the baseline assessment. Patients in the study group improve significantly better.

DISCUSSION

Patients with diabetic peripheral neuropathy show a high risk of falls because of impaired balance and proprioception. Therefore designing an appropriate intervention so as to overcome the complications of Diabetic neuropathy and improving their function is essential. Functional strength training involves the activities in everyday life given with focus of improving the strength of the lower limb muscles. Thus the study was conducted to determine the effects of FST and Balance training on Postural stability and Gait in patients with Diabetic neuropathy. The results of the current study showed a significant improvement in Postural stability and gait in subjects who received FST and balance training, after interventions there was a significant improvement in the components of BBS and DGI and ABC following FST exercises. Table 1 and graphs shows the mean and standard deviation and t value of BBS, DGI and Activities specific Balance Confidence scale. Interventions of standing balance training and LE Functional strengthening exercises are safe and may have contributed to improving the patient's functional mobility despite his progressive PPN. Future research would benefit current literature by investigating the effectiveness of standing balance exercises with internal and external perturbations in combination with LE strengthening exercises in patients with PPN. ST prevents muscle loss, it also improves inter muscular and intramuscular synchronization through neural control, contributing to improved stability and therefore gait. As seen in the results, there was a significant improvement in the values of BBS and DGI for the FST after intervention. In standing position, there is co contraction of agonist and antagonist muscles, leading to balancing of the body.

This balancing action of lower limb muscles seen in the standing position leads to erect standing. In diabetic neuropathy, due to the affection of sensory and motor nerves, there is impairment in balancing forces of the lower limbs and loss in proprioception. Thus, functional ST in the standing position must have challenged the balance of these patients thus imposing demands on lower limb muscles. The muscles may have counteracted for loss of proprioception thus leading to improvement in balance. Walking is a highly integrated function that requires the harmonized involvement of many physiological subsystems of the body. ST exercises increases muscle work in lower limbs, which can be considered a key factor in reducing gait alterations in diabetic people. The use of standing position in FST may have improved proprioception due to weight bearing (WB) on lower limbs which further leads to improvement in Postural stability and gait.

CONCLUSION

Functional ST and Balance training improve the outcomes of Postural stability and gait in diabetic neuropathy. However, functional ST and is effective in improving the outcomes of Postural stability and gait in patients with diabetic neuropathy. Balance training along with functional ST can be incorporated in the treatment interventions for individuals with diabetic neuropath

Declaration by Authors

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