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Augmented Targeted Training to Improve Balance in Diabetic Neuropathy Patients

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Abstract

Due to its high rates of morbidity, disability and death, diabetes mellitus with its long-term consequences is regarded as a public global health issue. In any specific period, between 12 and 50 percent of people with diabetes suffer with diabetic peripheral neuropathy (DPN). Motor nerve disorders and a loss of proprioception lead to impaired muscle action and imbalance. This study's main target was to find whether targeted strategy specific training along with verbal and visual feedback improved the efficiency of learning motor tasks that are identical. Out of 30, 15 patients were allotted to interventional group and other 15 were allotted to control group by simple sequential sampling. Patients in control group underwent standard balance training usually given as conventionally, while the interventional group received targeted strategy specific balance training along with augmentation. They received treatment for 2 consecutive weeks; 5 sessions per week. Both groups were assessed using MiniBEST test, before and after 2 weeks of intervention. In within group analysis using Paired t-test, intervention group had significant improvement statistically in all four components of balance, whereas control group showed improvement only in reactive postural control, sensory orientation and anticipatory postural control. In between group analysis using independent t-test, except anticipatory postural control all the other three components of balance showed statistically significant improvement. Augmented Targeted Training is effective in improving balance in DN patients.

Keywords: Augmented Training, Balance, Diabetic Neuropathy, MiniBEST Test.

Introduction

Due to its high rates of morbidity, disability and death, diabetes mellitus with its long-term consequences is regarded as a public global health issue. 5.3% of the global population, or half a billion people, are estimated to have diabetes by the World Health Organization. Commonly diabetes mellitus may result in diabetic peripheral neuropathy (DPN), which can affect up to 50% of persons with the disease, depending on the extent and duration of their diabetes (1, 2). Globally, 425 million people are thought to have diabetes mellitus, and in 2045, this is expected to increase to 629 million (3). While frequency of DPN is similar in people with T2DM and T1DM, there is likely more than one cause for the greater incidence of neuropathy in T2DM patients. Diabetic neuropathy is a specific degenerative condition affecting the peripheral nervous system, mainly impacting sensory, autonomic, and later motor axons to some extent (4). In diabetic peripheral neuropathy, there is a specific destructive pattern of nerve loss that involves initially sensory nerves and then motor nerves, with the last involvement manifesting as dying back. In fact, it appears that the primary cause of imbalance and difficulties in walking in DPN patients is loss of lower-limb muscular power. Due to above mentioned reasons, balance problems are more prevalent in diabetic neuropathy patients which may predispose individual to risk of fall (5, 6). Neurogenic muscle atrophy and the degeneration muscles cause patients to experience a decrease in their muscle strength, speed, and endurance as well as a reduction in their overall performance due to neural fatigue. In fact, it appears that the primary cause of imbalance and difficulties in walking in DPN patients is a loss of lower-limb muscular power. Above mentioned reasons, balance problem are more prevalent in diabetic neuropathy patients which may predispose individual to risk of fall (5). Balance is not a single characteristic; actually, it is the base of our ability to participate in a variety of activities that make up normal life. Balance control system activity and muscle tone changes throughout various activities including cleaning a

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high window, holding a struggling kid, walking across a busy road, and resting in an armchair. These changes are complex and varied (7). More significantly, the short and long term goal of treating DPN is to promote recovery of immature fibre degeneration while preventing the progression of neuropathic symptoms, neural function abnormalities, and associated decay (5). The physical activities in the balance training program alternate between static and dynamic conditions. Practices for transferring weight and maintaining balance include tandem standing, single-leg standing, and double-leg support with added head movement (8). Exercises done regularly can help avoid further loss of muscle strength and flexibility, comfort diabetic symptoms, and enhance neurological function—all of which make it difficult to completely reduce the symptoms of peripheral neuropathic especially balance (5). Exercises those are dynamic and complex, like balance training, could improve an individual's quality of life. Several programs have been created to make sure that people are properly trained in balance and fall prevention. Exercises that enhance general balance are the primary focus of the simple conventional methods (8). To improve focus on exercise program and feedback involved the patient actively in evaluating the achievement of goals and in correctly improving motor skills in response to appropriate feedback. Augmented feedback is a focused and structured feedback including visual and auditory feedback which assists learners in making connections between their movements and the actions that proceed. It aims to improve a specific performance. It is a deliberate and concentrated effort to address a particular need or goal, using specialised exercise (9). For supporting a participant's sensory input, augmented feedback provides more details about the way an action is performed. For improving motor learning, therapists usually use verbal feedback and commands for continued task completion. For minimize movement mistakes and for facilitating the fulfilment of the movement target in future efforts, feedback provides information based on previous movement attempts. Instructions may contain words containing information regarding performance or outcomes relevant to the task (10). Task-oriented programs for balance have advantages in improving balance, and practitioners should be trained about controlling their COM in relation to their BOS, whether it is changing or constant (8). Effectiveness of augmented targeted training which utilizes verbal and visual feedback improves balance in Diabetic neuropathy patients was found in this study.

Material and Methodology

The institutional Ethics committee for student's project, SRIHER approved the study with **REF**: **CSP/23/NOV/139/902**. This study was registered in CTRI-India. REF: CTRI**/2024/04/065252.** This Interventional study was done in Sri Ramachandra Hospital and Brindhavanam old age home, Chennai. Simple sequential sampling was used. Total study duration was 3 months and duration of intervention was 2 weeks. Subjects were explained about their interventions and consent/willingness for participation from all subjects was obtained. To be included for the study, subjects were required to possess a minimum score of 1 and above in Diabetic Neuropathy scale and 12 on the MiniBEST test. Patients with musculoskeletal and other neurological conditions were excluded. Using Simple sequential sampling subjects were allotted to interventional and control groups. Subjects from control received conventional balance training and interventional group underwent targeted strategy specific balance training with augmentation. Duration: 5 sessions per week, for 2 consecutive weeks. The subjects were tested pre- and post-intervention using MiniBEST test.

Results

In Table 1, the data was tabulated and analyzed using descriptive statistics. Within group analysis of interventional group and control group was done using paired t-test. Between group analysis of interventional and control group was done using independent t test. Within group analysis shows mean score and P value, all the components of balance showed statistically significant improvement in interventional group. Based on mean score and P values, except reactive postural control all other balance component Anticipatory postural control, sensory orientation and dynamic gait showed statistically significant improvement in control group.

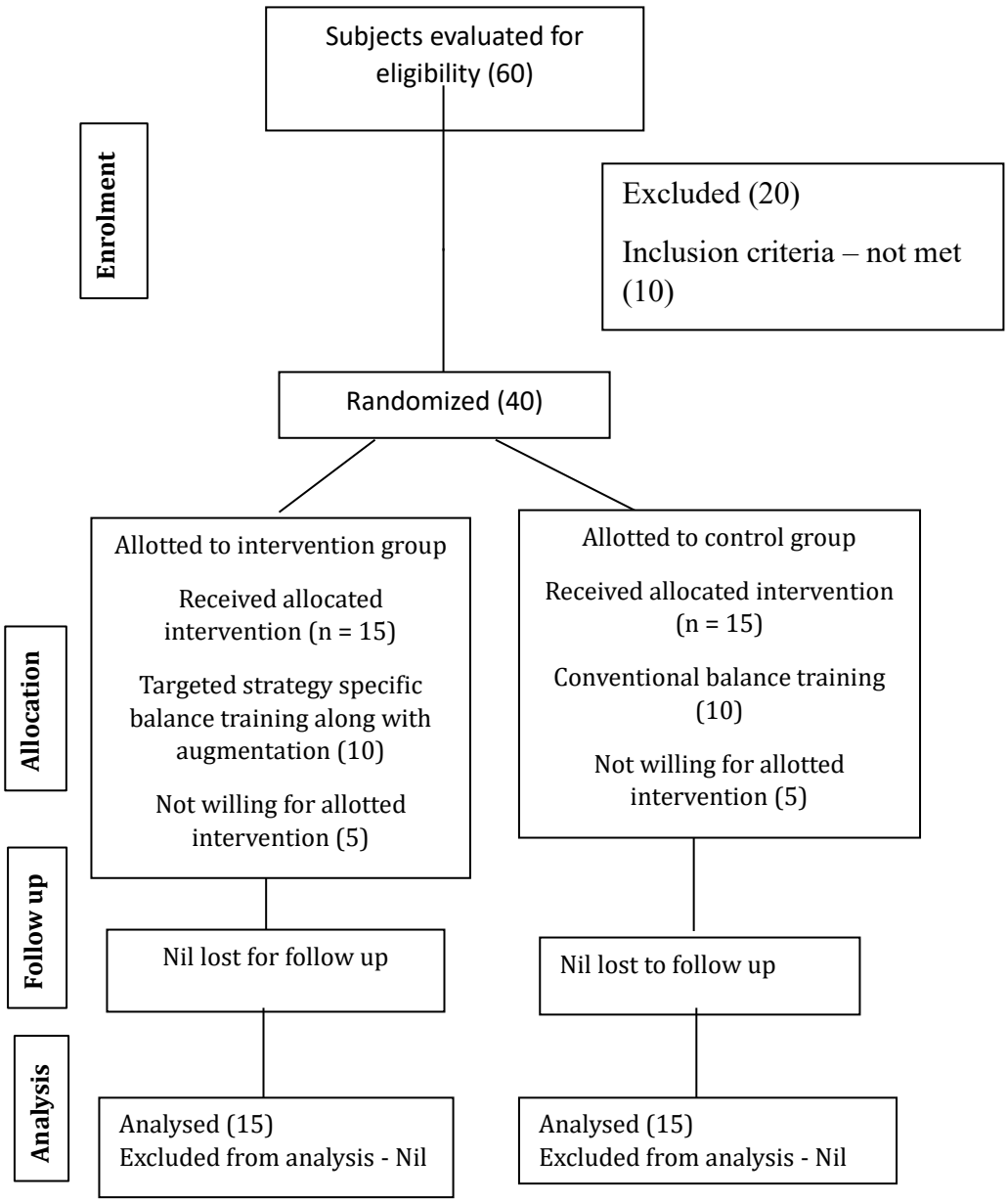

Figure 1: Consort Chart

Table 1: Analysis of Balance Components within Intervention Group and within Control Group

Components	Anticipatory Postural Control	Reactive Postural Control	Sensory Orientation	Dynamic Gait
Intervention Group				
Pre Test	3.13 (1.06)	3.26 (0.70)	3.13(0.35)	5.5 (1.18)
Post Test	4.20 (0.86)	4.33 (0.90)	4.20 (0.77)	6.86 (1.12)
P Value	< .001*	< .001*	< .001*	< .001*
Control Group				
Pre Test	3.00 (0.53)	2.86 (0.51)	3.13 (0.35)	4.8 (0.94)
Post Test	3.73 (0.70)	3.13 (0.83)	3.46 (0.74)	5.7 (1.33)
P Value	0.001*	0.104	0.055*	0.001*

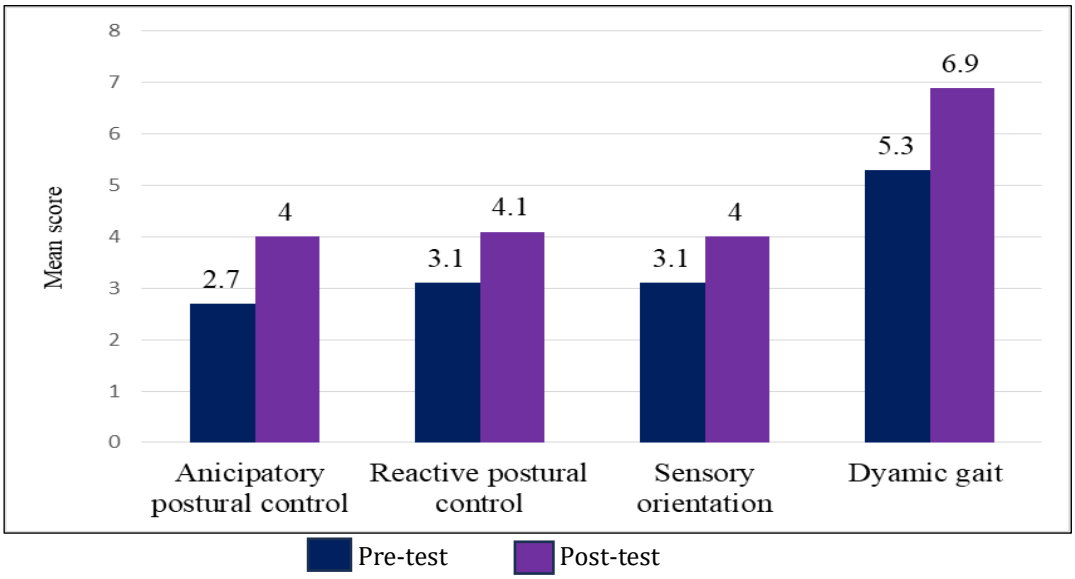

Figure 2: Analysis of Balance Components within Intervention Group

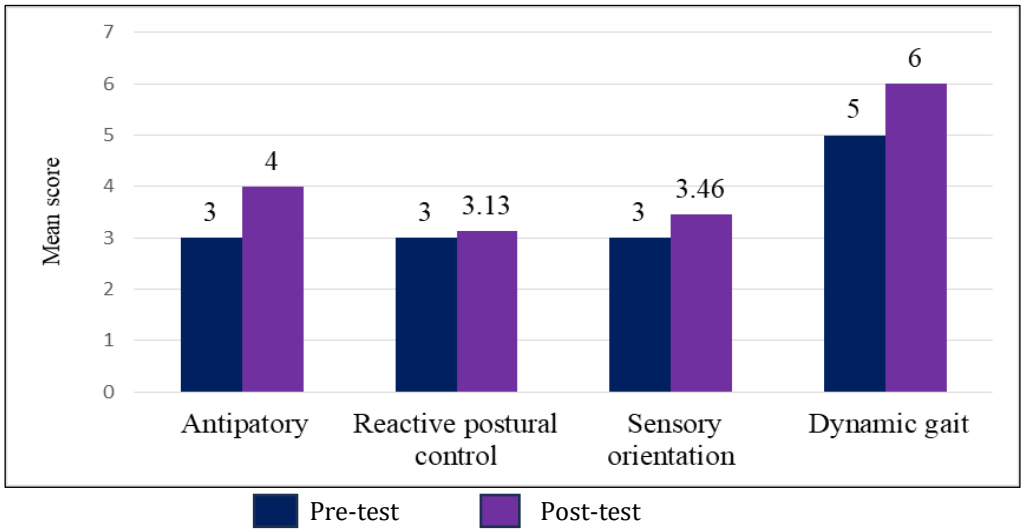

Figure 3: Analysis of Balance Components within Control Group

Table 2: Analysis of Balance Components between Intervention and Control Group

Components	Group		P-value
	Intervention	Control	
	Mean (SD)	Mean (SD)	
Anticipatory postural control	4.20 (0.86)	3.73(0.704)	0.116
Reactive postural control	4.33 (0.90)	3.13 (0.834)	<.001*
Sensory orientation	4.20 (0.77)	3.46 (0.74)	0.013*
Dynamic gait	6.86 (1.12)	5.73 (1.33)	0.018*

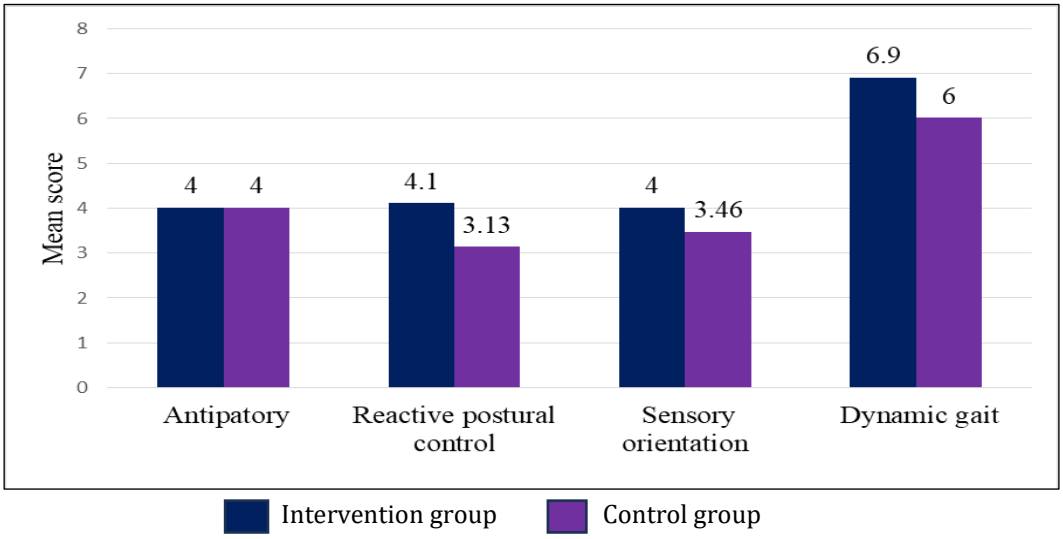

Figure 4: Analysis Of Balance Components Between Intervention and Control Group

In Figure 2, all components of balance have shown improvements within this group, more improvements noted in the dynamic gait component. In Figures 3, all components of balance have shown significant improvement. In Table 2, except anticipatory postural control all the other three components of balance showed statistically significant improvement. In Figure 4, only anticipatory postural control components have not shown significant improvement.

Discussion

This study determined if targeted training with augmented feedback given concurrently can improve learning of a balance task including sensory orientation, postural control both reactive and anticipatory, and dynamic gait. In this study 30 Diabetic Neuropathy patients were included. In intervention group 13 were females and 2 were males, in control group 8 were females and 7 were males. In within group analysis of intervention group, all the components of the balance showed statistically significant improvement. In within group analysis of control group except reactive postural control component, all the other anticipatory postural control, sensory orientation, and dynamic gait are statistically significant. Based on mean score reactive postural control is showed improvement in pre and post intervention it should implies clinically significant. In between group analysis based on mean score and P value except anticipatory postural control, All the other components of balance including reactive postural control, sensory orientation, dynamic gait have shown improvement significantly. In a study, task-oriented training was found to be more effective than conventional training of balance to improve anticipatory and dynamic components of balance in old, aged population (8). In another similar study, with in elderly population dynamic balance have improved with task specific training (11). When it's to increasing their balance and overall

gait speed, when performing single tasks. This study shows no changes in baseline criteria variables, when traditional exercises and visual feedback are given together. Seung-jun hyun in his study suggest, Parkinson's patients it was found that task specific training with visual feedback performed tasks in the better manner (12). In stroke patients, it was found that augmented visual feedback and combined with gait training improved mobility (13). It stated that the feedback training didn't show any significant changes in improving Static balance control (9). Even when feedback was provided for upper and lower muscular performance using resisted exercises, significant improvements were found. Jayavan, in another study done on hemiplegic patient's auditory feedback resulted in improved balance and ability to maintain the posture required to finish the task This is supported by another study done by Jennifer c Nitz (14). Nida Chaudhary stated that, instead of providing only visual feedback, a combination of both feedbacks-verbal and visual improves balance in the stroke population (15). In this study, verbal and visual augmented feedback improves neuromuscular control in the female population (16). A study done by Jarosław Jaszczur-Nowicki stated that the combination of feedbacks improves performance in the younger population (17). It shows similarity with another study, where combined auditory and visual feedback were provided functional balance showed greater improvements(18). Based on the findings of this study and above-mentioned studies, augmented targeted training improved balance in diabetic neuropathy patients. Early improvements in greater level have occurred in all components of balance in acquisition period. This type of targeted training with augmented feedback allows the DPN patients to identify any errors occurring in balance control, helping to be aware of problem and self-correction. Feedback also resulted in other benefits like improving the physiological compromised arousal. It improved efficacy and confidence in balance and could be largely useful for rehabilitating DPN patients and other patients with compensated balance confidence.

Conclusion

Based on the findings from the above study, augmented targeted training with visual and auditory feedback was found to be effective in improving sensory orientation, postural control both anticipatory and reactive, and dynamic gait than conventional balance training in DPN patients. In future, this training protocol could be recommended to improve functional balance, reduce risk of fall and thus quality of life in DPN patients. Future research could further explore the long-term sustainability and broader applicability of these interventions in diverse demographic and clinical contexts.

Abbreviation

Nil.

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Nil.

Author Contributions

Ms.Thenmozhi. M and Ms. A. Rajarajeswari contributed equally to the conceptualization, methodology, data analysis and writing of this article.

Conflict of Interest

No conflict of interest attached to this study.

Ethics Approval

Approval obtained from IEC, SRIHER. REF: CSP/23/NOV/139/902.CLINICAL TRIAL REGISTRY NO - CTRI/2024/04/065252

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