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Blindfolded balance training versus swiss ball exercises on static and dynamic balance in subjects with diabetic neuropathy

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Abstract
Background: Balance is maintained with the information from somatosensory input, visual and vestibular systems. Somatosensory input and vision are often affected in presence of diabetic neuropathy. Decreased vibration sense can trigger imbalance.
Objectives: To compare the effect of blindfolded balance training and Swiss ball exercises on static and dynamic balance in subjects with Diabetic Neuropathy.
Methods: 30 subjects with Diabetic Neuropathy were recruited for the study and assigned to one of the two groups. Group A received Blindfolded balance training and Group B received Swiss ball exercises. The treatment sessions were scheduled for 45 minutes a day, 5 times per week, for 3 weeks. Balance was assessed prior to and post-intervention using Berg Balance Scale and Star Excursion Balance Test.
Result: Pre-intervention score of BBS was 33.60±1.99, SEBT for right lower limb was 37.78±1.88 and 34.48±1.98 for left lower limb in Group A. In Group B, BBS score was 34.80±1.62, SEBT score in right lower limb was 41.65±3.61 and in left lower limb was 39.12±3.40. Post-intervention, the BBS score was 36.60±1.56, SEBT score in right lower limb was 40.50±2.06 and left lower limb was 36.80±2.25 in Group A. BBS score was 42.13±2.46, SEBT score in right lower limb was 49.40±3.37 and in left lower limb was 47.38±2.34.
Conclusion: Both the groups showed significant improvement post-intervention. But between group comparison showed Swiss ball exercises to be more beneficial in improving static and dynamic balance in subjects with Diabetic Neuropathy.

Keywords: diabetic neuropathy, blindfolded balance training, Swiss ball exercises, balance, berg balance scale, star excursion balance test

Introduction

Diabetes Mellitus, a metabolic disorder is characterized by hyperglycemia which results either from defects in insulin secretion, its function or both [1]. Diabetic peripheral neuropathy (DPN) is the most common complication of diabetes and occurs in about 60-70% of this population worldwide [2]. Neuropathy is characterized by a progressive loss of small and large peripheral nerve fibers [3], leading to sensory loss, paresthesias and neuropathic pain that follows a "glove and stocking" type of distribution, initially affecting the toes and then progressing upward in the lower extremities [4, 5, 6], further leading to altered plantar pressure, deficits in balance, proprioception, postural control and gait [7, 8, 9]. Postural instability can lead to higher incidence of falls in elderly individuals with diabetes than when compared to age-matched healthy individuals [10].

Proprioception is the ability to perceive joint position and its movement and helps in joint stability, postural control and correction [11]. It helps to monitor the progression of a movement sequence and is mediated by mechanoreceptors which distinguish the temporal and spatial information about foot pressure [12]. Feedbacks from the tactile and proprioceptive systems help in maintaining balance. When conduction of somatosensory information from the periphery to the Central Nervous System (CNS) and the compensatory mechanisms are affected, balance can get affected [13]. Balance and gait are critical for most of the functional movements and independence in day-to-day activities [14]. Balance requires input from vestibular, visual and proprioceptive receptors [12, 15]. Balance training can reduce fall risk and improve quality of life [16]. Strength training, stretches, generalized balance and gait training have always been a part of conventional approach [17].

Task-oriented balance training helps individuals in improving both static and dynamic balance. Practicing weight shifts and balance training can be done standing with unilateral and bilateral leg support and tandem standing with variations in head positions [18]. Balance training using blindfold helped individuals with Parkinson's disease in improving their static and dynamic balance [19] but its efficacy in subjects with diabetic neuropathy is not widely studied. Hence, this study aimed to understand the effect of blindfolded balance training on static and dynamic balance in subjects with diabetic neuropathy and also to compare its effect with Swiss ball training.

Methodology

30 subjects who fulfilled the inclusion criteria were recruited for the study from a tertiary care center in Bangalore. Male and female subjects among the age group of 45-65 years who were diagnosed with diabetic neuropathy by a neurologist, subjects having diabetes since 10 years, having a score of 21-50 on the Berg Balance Scale and who were able to walk for 5 minutes with blindfold

were included in the study. Subjects with diabetic foot, foot ulcers, visual impairments without correction, subjects with a history of any surgery in the lower limbs that can affect training, dizziness or falls, usage of antidepressants within the last 2 months, unstable medical conditions or any other neurological disorders, unco-operative subjects and individuals who were already a part of any physiotherapy protocol were excluded. Informed consent was taken from all the eligible subjects and Ethical Clearance was obtained from the Institution. Subjects were then randomly assigned into two groups, 15 to each group. Demographic details such as name, age, gender, BMI and duration of diabetes were noted. Berg Balance Scale and Star Excursion Balance Test were used to assess static and dynamic balance respectively, prior to- and post-intervention [20, 21, 22, 23, 24]. Both the groups received the intervention for 45 minutes a day, 5 days a week for a period of 3 weeks. Exercise sessions consisted of 5 minute warm-up, 35 minutes training and 5 minutes of cool-down.

Subjects in Group A received Blindfolded balance training which was given in two parts [19].

1. Marching in place

Participants were asked to stand on a foam cushion of 10 cm height and then blindfolded. Subjects were then asked to stretch their arms forward with shoulder flexion of 90^0 against the wall, as a reference point. Once the subjects perceived the position, they were asked to move away 5cm from the wall, so that their hands no longer touch the wall. Subjects were then asked to march in this position with arms stretched forward for one minute. After that, the subjects were asked to turn 90˚ clock-wise and repeat the same exercise for another one minute and later at 180˚ and 270˚ for a total of 4 minutes. Subjects were guided by a therapist using verbal clues whenever there was a mistake in changing the direction.

2. Treadmill training

Subjects initially walked on a treadmill for a minute with eyes open at their comfortable walking speed. Subjects were then blindfolded and were asked to walk on the treadmill without support for 4 minutes. Therapist guided the subjects using verbal cues whenever required, to maintain the appropriate direction. The speed of treadmill was set at 1km\hour and was increased by 0.5 km\hour every minute, till it reached a speed of 3km\hr.

Subjects in Group B received swiss ball training. The exercise training was done in sitting and standing. Training in sitting included sitting on the swiss ball and maintaining balance, active movements of upper extremities, trunk movements in all directions, heel and toe raises simultaneously and alternately. Training in standing included moving the swiss ball up and down in a straight line and obliquely with both the upper extremities, moving the ball forward, backward and laterally using the lower limbs, throwing the swiss ball against the wall and kicking the ball to the wall.[25]

Results

Table 1: Distribution of subjects with Diabetic Neuropathy according to age, gender and duration of Diabetes Mellitus over the groups

Characteristics	Group A	Group B
Age in years	52.67±4.17	51.00±4.27
Male / Female	10(66.7%) / 5(33.3%)	10(66.7%) / 5(33.3%)
Duration of DM (in years)	13.33±2.12	13.40±2.55

Table 2: Range, mean and SD of outcome measures of subjects with diabetic neuropathy in Group A

S. No.	Outcome measures	Group-A				Paired t-test/ Wilcoxon test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	BBS	31-37	33.60±1.99	35-39	36.60±1.56	z=3.436*	p<0.001
2	Right limb SEBT(cm)	34.2-41.7	37.78±1.88	36.2-45.6	40.50±2.06	t=11.230*	p<0.001
3	Left limb SEBT(cm)	31.0-37.8	34.48±1.98	32.0-39.8	36.80±2.25	t=11.723*	p<0.001

Note: * denotes –Significant. t- paired t-test, z- Wilcoxon test.

Table 3: Range, mean and SD of outcome measures of subjects with diabetic neuropathy in Group B

S. No.	Outcome measures	Group-B				Wilcoxon test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	BBS	32-37	34.80±1.62	38-45	42.13±2.46	z=3.436*	p<0.001
2	Right Limb	34.6-48.5	41.65±3.61	44.8-55.2	49.40±3.37	z=11.230*	p<0.001
3	Left Limb	32.6-44.4	39.12±3.40	43.3-52.3	47.38±2.34	t=11.723*	p<0.001

Note: * denotes –Significant. t=paired t-test, z- Wilcoxon test.

Table 4: Comparison of pre and posttest outcome measures of subjects with Diabetic Neuropathy in between the groups

S. No.	Outcome measures	Pre test		Post test	
		Group-A	Group-B	Group-A	Group-B
		Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
1	BBS	33.60±1.99	34.80±1.62	36.60±1.56	42.13±2.46
2	Right Limb	37.78±1.88	41.65±3.61	40.50±2.06	49.40±3.37
3	Left Limb	34.48±1.98	39.12±3.40	36.80±2.25	47.38±2.34

Between group comparison Mann-Whitney U test	▪ BBS: z=1.478, p>0.05, NS ▪ Right limb SEBT (cm) t=1.891, p>0.05, NS ▪ Left limb SEBT (cm) t=1.241, p>0.05, NS	▪ BBS: z=4.497, p<0.05, S ▪ Right limb SEBT(cm) t=8.865, p<0.05, S ▪ Left limb SEBT(cm) t=12.598, p<0.05, S

Note: S-denotes significant (p<0.05); NS-not significant (p>0.05).

Discussion

The present study aimed at comparing the effect of blindfolded balance training and swiss ball exercises on static and dynamic balance in individuals with Diabetic Neuropathy. 30 participants were assigned to one of the two groups, 15 in each group. Static and dynamic balance were assessed prior to and after the training at 3 weeks using Berg Balance Scale and Star Excursion Balance Test.

Subjects in Group A received Blind folded balance training. Post-intervention, scores on the Berg Balance Scale and Star Excursion Balance test have improved which signify improvement in static as well as dynamic balance (p<0.001). The results of this study are in line with M. Tramontano and colleagues who observed reduction in double stance phase with blindfolded balance training in subjects with Parkinson's disease. It could be due to the subjects' improved ability to transfer the body weight during gait and postural stability. Integration of sensory inputs from visual, somatosensory and vestibular systems is the key to good balance. The authors hypothesized that the vestibulospinal stimulation may contribute to facilitate anticipatory postural adjustments that are required to perform voluntary movements and also mentioned that reflex balancing needs good proprioceptive, visual and vestibular integration.[19]

Subjects in Group B received Swiss ball training and the results showed improvement in balance on the Berg Balance Scale as well as the Star Excursion Balance Test (p<0.001). As discussed earlier, balance can get affected with any impairment in visual, sensory or the vestibular systems leading to postural instability. Swiss ball training helps in improving sensory input and also in reduction of unwanted body movements which in turn can help in better balance as observed in this study. When pertubations are given using swiss ball, anticipatory and compensatory strategies are used to maintain balance. Swiss ball training consisted of internal and external pertubations and both control mechanisms for feed forward balance were used during the training [25]. Another study observed reduced Body Mass Index and glycated hemoglobin with swiss ball training. Exercises using stability ball helped in improving core muscle strength, endurance and balance in diabetic women with sedentary lifestyle. It was also observed that insulin absorption was better with lower extremity exercises [26].

Prior to the intervention, there was no significant difference observed between the groups (p>0.05) representing the homogeneity of the participants in both groups. Post-intervention, both swiss ball exercises and blind folded balance training were individually found to be effective in improving balance among the subjects with diabetic neuropathy. But, there was a significant improvement between the groups (p<0.05) indicating that swiss ball exercises were more effective than the blindfolded balance training to improve balance among subjects with diabetic neuropathy. Exercising on swiss ball puts a greater challenge on dynamic balance, co-ordination and can activate trunk muscle activity improving core stability and trunk control. Swiss ball exercises help in facilitating postural and trunk control, sitting & dynamic balance and can help attain better co-ordination, balancing between various body systems and contextual effects [27] which could have led to better improvement in the swiss ball group.

The main limitation of this study was that the BMI of the subjects was not considered and long term follow-up was not done due to which the retention effect of the results couldn't be observed. It was also observed that there was less awareness among subjects regarding the blindfolded balance training compared to swiss ball training. Future studies can study the effect of these training protocols in other neurological conditions. Effect of BMI and age on the results can be studied to understand the importance of weight control and early rehabilitation in subjects with Diabetic Neuropathy.

Source of data

Padmashree Physiotherapy Clinic and Padmashree Diagnostics.

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Ethical clearance

Obtained from the Institutional Ethical Committee of Padmashree Institute of Physiotherapy.

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