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A Study of the Effect of Stability Trainer on Dynamic Balance in Distal Sensory Diabetic Neuropathy

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Abstract

The purpose of this study was to determine the effect of stability trainer on dynamic balance in patients with distal sensory diabetic neuropathy (DSDN). Thirty subjects of both genders were divided into 2 groups. Experimental group received 45 minutes conventional physiotherapy & 15 minutes balance training on stability trainer while control group received 45 minutes of conventional physiotherapy. *Results:* There was significant difference between pre to post readings of DGI & TUG in both groups with overall percentage of DGI 24.5% & TUG 31.89% in experimental group and DGI 12.94% & TUG 11.82% in the control group. In pre to follow up readings there was significant difference with DGI 14.56% &TUG 30.31% in experimental Group and DGI 7.46% & TUG 6.94% in control group. *Conclusion:* It was concluded that training on stability trainer with conventional physiotherapy is more effective than conventional physiotherapy alone, in improving dynamic balance.

Introduction

Diabetic peripheral neuropathy (DPN), a microvascular complication of diabetes, is associated with considerable mortality, morbidity and diminished quality of life. Characterized by pain, paresthesia and sensory loss, it affects up to 50% of patients with diabetes with new cases occurring at an annual incidence of about 2%. In absolute numbers, against the estimated global prevalence of 220 million cases of diabetes by 2010, DPN is likely to affect as many as 110 million persons worldwide and at tremendous cost *(Solomon, 2001).* Neuropathy is a common and serious complication of diabetes mellitus. The most common type of neuropathy associated with diabetes mellitus is diabetes sensory polyneuropathy (DSPN). The associated symptoms of DSPN are typically described as symmetrical sensory loss to all modalities often referred to as a "dying back" phenomenon. Described as an axonal length-dependent pathology, referencing the distance from the dorsal root ganglion to the sensory receptor, DPSN allegedly produces an almost universal finding of stocking distribution sensory loss in the lower extremities and glove distribution sensory loss in the upper extremities *(Andrew et al, 2008).* Patients with type 2 diabetic neuropathy (DN) are at an increased risk of falls. This increased

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risk is presumably due to the well-documented balance problems attributed to neuropathy and sensory ataxia, which is the lack of accurate proprioceptive feedback. Sources of instability in patients with type 2 DN include the loss or reduction of peripheral sensory information in the feet, the inability of the central nervous system (CNS) to appropriately integrate available postural control information, and a switch from an ankle-based to a hip-based balance strategy *(Hoda et al, 2011).* Proprioception is the ability to perceive position and movement. This ability allows for the monitoring of the progression of any movement sequence and makes later movements possible. It is a sensory modality mediated by mechanoreceptors, which are receptors found in muscles and neurotendinous organs. The function of mechanoreceptors is to discriminate between temporal and spatial information about pressure of contact on the feet. When the sensitivity in the sole of the information coming from mechanoreceptors decreases, there is decline of balance in the elderly and in individuals with diabetes *(Santos et al, 2008). Jain & Rathod (2015)* reported a relationship between balance impairments and changes in ankle range of motion (ROM) in older women who have fear of fall.

Material & Methods

Thirty patients of DSDN were included in the study using convenient random sampling of both gender aged 55-65yrs, moderate neuropathy score 9-11 according to TORANTO Neuropathy score, bilateral positive Semmes Weinstein monofilament test, able to make unipedal stance for 20 seconds, ability to complete two minute walk, strength of ankle muscles at least antigravity were included. Patients with vestibular dysfunction, CNS dysfunction, musculoskeletal deformity, cardiovascular problems, plantar ulcers, visual defects, BMI above 30 were excluded.

The sample was randomly divided into 2 groups, experimental & control group consisting 15 patients each. Experimental group received one hour treatment including 45 min conventional physiotherapy & 15 min balance training on stability trainer for 4 times a week for 4 weeks i.e total 16 sessions/month. The control group received conventional physiotherapy of 45 min for 4 times a week for 4 weeks. DGI & TUG test reading was taken before session, after session and follow up on 8th week.

The protocol was as follows

1) Relaxed deep breathing exercises (3 minutes)

2) ROM exercises for bilateral ankle joints (5 minutes)

3) Functional balance training (15 minutes)

(a) Sit to stand (5 times), (b) Standing weight shift (5 times), (c) Functional reach-sideways and forward (5 times each), (d) Bipedal heel rise for 20 seconds (5 times), (e) unipedal stance for 15 seconds (5 times), (f) unipedal standing with knee bending for 15 seconds (5 times)

4) Wobble board training (6 minutes)

5) Gait training

a) Tandem walk (5 minutes), b) Spot marching (5 minutes)

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A set of exercises on stability trainer:

Level of challenges were increased by increasing the order of instability from green, blue, black with rounded point surface, black with antiskid surface. Each level of challenges practiced for 4 sessions.

a) Bipedal heel rise for 20 seconds (5 times), (b) One leg balance with maintain posture for 15 seconds for both legs (5 times) (c) Hip flexion of 90 degree on one leg with maintain posture for 15 seconds for both legs (5 times) (d) Hip extension on one leg with maintain posture for 15 seconds for both legs (5 times) (d) Knee bending to keep the knee up to 90 degree flexion, maintain the posture for 15 seconds & repeat the exercise over the other leg (5 times).

Results and Discussion

There were no statistically significant differences between the groups for any of the baseline characteristics. Group analysis showed that there was significant difference between pre to post readings of DGI & TUG the groups with overall percentage of TUG 31.89% & DGI 24.5% experimental group & TUG 11.82% & DGI 12.94% in control group. In pre to follow up there was significant difference in DGI & TUG scores with TUG 30.31% & DGI 14.56% in experimental group & TUG 6.94% & DGI 7.46% in control group. When we observed the post to follow up readings there was no significant difference in TUG readings in experimental group but there was significant difference in other readings.

Table 1: Showing the mean values of DGI scores b/w group A & Group B

	Group	MEAN SD	P-value	Significance
Pre DGI	Group A	14.531±.68	.628	P > .05
	Group B	14.80±1.26		
Post DGI	Group A	18.00±1.31	.005	P < .05
	Group B	16.67±1.05		
Follow up DGI	Group A	16.53±.99	.086	P > .05
	Group B	15.87±1.06		

Table 2: Showing the mean values of TUG scores b/w group A & Group B

	Group	Mean±SD	P-	Significance
Pre TUG	Group A	19.20 ±1.08	0.87	P >.05
	Group B	19.13 ±0.12		
Post TUG	Group A	13.07±0.79	0.00	P < .05
	Group B	16.87 ±0.06		
Follow up TUG	Group A	13.33 ±0.41	0.00	P < .05
	Group B	17.80±1.26		

Table 3 shows mean value of DGI scores within group

Group			Mean± SD	P-	Signi-ficance
Group A	Pair 1	Pre DGI – post DGI	3.47±0.64	0.00	P<.05
	Pair 2	Pre DGI – follow up DGI	2.00±0.93	0.00	P<.05
	Pair 3	Post DGI – follow up DGI	1.47±0.52	0.00	P<.05
Group B	Pair 1	Pre DGI – post DGI	1.87±0.83	0.00	P<.05
	Pair 2	Pre DGI – follow up DGI	1.07±0.70	0.00	P<.05
	Pair 3	Post DGI – follow up DGI	0.80 ±0.4	0.00	P<.05

Table 4 shows mean value of TUG scores within group

Group			Mean ± SD	P	Significance
Group A	Pair 1	Pre TUG – post TUG	6.13± 0.83	0.00	P < .05

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	Pair 2	**Pre TUG – follow up TUG**	**5.87± 2.70**	**0.00**	**P < .05**
	Pair 3	**Post TUG – follow up TUG**	**0.27± 2.60**	**0.69**	**P >.05**
Group B	**Pair 1**	**Pre TUG – post TUG**	**2.27± 0.59**	**0.00**	**P<.05**
	Pair 2	**Pre TUG – follow up TUG**	**1.33± 0.82**	**0.00**	**P<.05**
	Pair 3	**Post TUG – follow up TUG**	**0.93± 0.80**	**0.00**	**P<.05**

Dynamic gait index (DGI) & timed up & go (TUG) were used to asses patients balance & significant difference between pre & post scores on statistical analysis were observed. While in follow up which was taken 4 weeks after the post test reading, a change in DGI readings was observed but TUG scores remain the same in experimental group which indicates that improvement in balance remain constant even one month after the post treatment. However no significant difference between TUG post test & follow up readings were observed. Proprioception is a factor often compromised in diabetic neuropathy which may lead to reduced balance, increased risk of falling & subsequent fear of falling, so it is important to focus on improving balance which can reduce incidence of falls & sustained injuries. This study focussed on balance in DSN patients which can be improved by balance training on stability trainer & helps to reduce the fall risk. A study done by *Ajimsha, et al (2011)* supported the results of the present study who also found that stability trainer is effective for improving static balance with distal sensory diabetic neuropathy. A study done by *Shah & Jayavant (2006)* on ambulatory hemiplegic patients found that training on stability trainer in different posture, at appropriate challenge levels, helps to improve balance in these patients. Extrinsic feedback from therapist about their posture & intrinsic feedback from stability trainer helps them in improving balance. Somatosensory training using stability trainer can also augment increased proprioceptive firing from the cutaneous receptors from the feet & also from mechanoreceptors of the muscles during co-contraction produced by the swaying movements, while standing on stability trainer. The greater improvement in the experimental group as compared to the control group might be due to the fact that, practicing balance training in progressive challenging levels is indicative of its potential to enhance somatosensory integration with visual & vestibular senses in CNS. Stability trainer provides an unsteady surface that challenges the body to maintain balance. During the exercise intervention with stability trainer, sensory inputs could be manipulated by altering the support surfaces & environments.

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Conflict of Interest: None Declared