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Effect of Multisensory Exercise Training on Sensation and Balance in Patients with Diabetic Neuropathy – A Pilot Study

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ABSTRACT

Background: Diabetic peripheral neuropathy, is a common manifestation of peripheral nervous system in diabetes due to elevated glucose level. Symptoms include painful lower limbs, altered sensation, reduce reflexes and weakness of lower limb resulting in impairment in balance and gait. As treatment various interventions are used such as balance training, strength training, aerobic exercise, sensory motor training.
Aim of study: This study was to assess the effect of multisensory exercise training on sensation and balance in patients with diabetic neuropathy.
Methodology: This study was conducted in various OPDs and diabetic center of Surat. 10 diabetic neuropathic patients were randomly assigned in to 2 groups; 5 patients were allocated in group A (conventional & multisensory training) and 5 patients were allocated in group B (conventional therapy). Patients in both groups were treated for 3 days per week for 4 weeks. Conventional physiotherapy was given for 3 days in a week at home for 4 weeks. Sensation and balance were assessed by using Semmes-Weinstein Monofilaments and berg balance scale respectively. Data were recorded at baseline and after 4 weeks of training.
Result: The result showed there was no significant difference in effect of multisensory exercise on sensation and there was significant improvement in balance in patients with diabetic neuropathy.
Conclusion: The result of study indicate that 4 weeks of multisensory exercise program was improving balance in patients with diabetic neuropathy as compare to conventional therapy.
KEY WORDS: Multisensory exercise, Sensation, Balance, Diabetic neuropathy.

BACKGROUND

Diabetes mellitus is the commonest global metabolic disease at present and its prevalence is gradually increasing day by day across the world, especially developing nations [1]. According to the latest facts and figure provided by International Diabetes Federation, 463 million people were living with diabetes globally and 374 million people are at an increased risk of developing type 2 diabetes mellitus (T2DM). In India around 77 million people are living with diabetes in 2019 and by 2045 this will rise to 134.2 million [2]. The prevalence of

DPN was 44.9% with almost equal prevalence among males (46.2%) and females (44.4%) [3].

Diabetic neuropathy (DN) defined as the presence of certain signs or specific symptoms and suggestive for neuropathy in patients with diabetes mellitus (DM), after excluding other possible causes of neuronal damage [4]. DN is the most common microvascular complication encountered in DM individuals; after 20 years of disease progression, more than 50% of DM patients are affected by this complication with a significant impact on their life quality, considering the characteristic chronic pain in their lower limbs [1]. Chronic sensorimotor distal symmetrical polyneuropathy is the most common form of Diabetic Peripheral Neuropathy [5].

Polyneuropathy can lead to sensory loss, muscle weakness and pain. The typical presentation includes burning sensation and numbness in the feet [4]. Clinical signs of DPN include bilateral lower extremity loss of touch, pressure, vibratory, position, and temperature sensory perception and decreased ankle reflexes. Signs and symptoms depend on whether large and/or small nerve fibres are affected. Diabetes can increase 1accidents through poor balance issues due to numbness in the toes and feet [6].

Loss of foot sensitivity is a relevant parameter to assess and prevent in several diseases like diabetic neuropathy. Medication, whole body vibration, tens etc, were used as treatment protocol for vibration perception threshold [7]. In diabetic neuropathy sensation loss is very common symptom [8]. In patients with diabetic neuropathy reduction in somatosensory perception has detrimental effects on postural stability, resulting in an increased risk for falling [9]. Tactile stimulation, proprioceptive stimulation, vibratory stimulation, strength training, endurance training, balance training, resistance training, etc are used to improve sensation in diabetic patients [8].

sensory specific exercises chiefly use stimulation procedures to help sensory impaired patients recover sensibility, fine discrimination abilities and the skill to carry out other tasks involved in daily life and work place [10]. It helps patients with sensory loss and impairment to retrain their sensory pathways, adapt to changed capacities, and regain function. Multisensory exercise programmes, were considered as a new strategy to improve physical function [11].

Monireh Asadi Ghalen found that multisensory exercise training improves static and dynamic balance in older women with diabetic polyneuropathy [12]. In-Gyu Yoo, found that Multisensory balance training for unsteady elderly people. In this study author discuss about the application of multisensory training for elderly people at risk of falling could have a positive impact on the function recovery of training participants [13].

The aim of this study was to determine the effect of multisensory exercise training on sensation and balance in patient with diabetic neuropathy. Because the previous study was conducted in other countries, there were very less study should be done on Indian population on multisensory exercise training.

MATERIAL & METHOD

Ethical clearance was taken from institutional ethical committee (IEC). The 10 diabetic neuropathic patients were recruited from various diabetic centre of Surat. The purpose of the

study was explained and written informed consent and demographic details was obtained from all subjects. Patient allocation was done on the basis of random sampling method. They were divided into two groups Group A and Group B. Inclusion criteria were (1) Age 40 – 65 years (2) Type 1& 2 diabetes mellitus more than 3 years (3) Diagnosed cases of diabetic neuropathy with lower limb involvement on basis of NCV reports (4) Patients who are able to walk for 6 min. (5) Modified Toronto clinical scoring system (score > 6). Exclusion criteria were (1) Any musculoskeletal disorder affecting the lower limb (fracture of Lower limb, tumors, any infection, ligament injuries) (2) Peripheral vascular disease (3) Common peroneal nerve injury (4) Any other neurological disorder (influence gait Variables like stroke, Parkinson disease, cerebellar dysfunction, ataxia, vestibular disorders) (5) Any other cardiovascular disease (Cardiac arrhythmias, cardiac pacemakers).

Intervention:

GROUP – A: MULTISENSORY EXERCISE TRAINING + CONVENTIONAL THERAPY

Multisensory exercise training

In Multisensory exercise training protocol Special and focused exercises were given with emphasis on senses which are as follows:

Warm up and cool down:
Ankle plantar flexion and dorsiflexion,
Inversion and eversion (10 reps),
Short walk (5 min)
Self stretching of calf and hamstring muscles. (3 reps with 30 sec hold).

Touch: Walking on different surfaces
Regular floor (5min),
Mattress (5min) and
foam rubber(5min).

proprioception and vestibular stimulation: walk forwards, backwards, and sideways, with eyes both open and closed, at different speeds (starting with normal speed, in between ask patient to walk fast and slow) and for various distances.

Bipedal support- unipedal stance, Eye open, firm surface, Eye open, soft surface, Eye closed, firm surface, Eye closed, soft surface (10 sec hold).
Double legged stance(10s),
Tandem stance(10s),
Tandem walking(3min),
obstacle walking(3min),
Each exercise will be performed for 5 times. [14,11,15]
30 sec rest in between each exercise.

Conventional therapy:

In this group Standard care was given by physician for patients comprising of glycaemic control, diet advice (Offer the patient frequent sips of sugar-free fluids, and blood glucose is

<15mmol/l) and palliative care for neuropathic pain. 25 min walking exercise prescription to be done 3 days in a week at home for 4 weeks [8].

GROUP – B: CONVENTIONAL THERAPY

In this group Standard care was given by physician for patients comprising of glycaemic control, diet advice (Offer the patient frequent sips of sugar-free fluids, and blood glucose is <15mmol/l) and palliative care for neuropathic pain. 25 min walking exercise prescription to be done for 3 days in a week at home for 4 weeks [8].

Outcome measures:

1.Semmes-Weinstein Monofilaments (SWM):
The SWM to monitor sensory impairment. Monofilament was applied to the plantar surface of the great toe and using a simple forced-choice procedure the smallest monofilament felt by the patient was recorded [15,16].

2.berg balance scale:
It comprises 14 tasks testing postural stability, including static balance (e.g., standing unsupported with feet together) and dynamic balance (e.g., placing alternate foot on a step while standing unsupported). Depending on the performance, each task is rated from 0 (unable to perform the task) to 4 points (best performance), with a total score ranging from 0 to 56 points. The BBS proved to be a valid assessment tool when compared with laboratory measures of postural control and clinical measures of balance and mobility [16].

Statistical Analysis: Analysis of data were done by using SPSS version 20.00. descriptive analysis was done calculating mean and standard deviation. Normality of distribution was done by using the Shapiro wilk test. For normally distributed data, paired t-test was used for within group comparison and independent sample t-test was used for between group comparison. The level of significance was set at 95%($p<0.05$).

RESULT:

Table 1: Baseline Characteristics

CHARACTERISTICS		FREQUENCY(N)	%
Age group(years)	40-45	1	10%
	46-50	0	0
	51-55	0	0
	56-60	5	50%
	61-65	4	40%
Gender	Male	6	60%
	Female	4	40%

Table 2: Within group comparison of differences of means.

Group	Outcome measures	Pre-test score		Post-test score		P-value	Applied test
		Mean	SD	Mean	SD		
Group A	SWM	5.93	1.07	5.20	1.07	0.011($p<0.05$)	Paired t-test
	BBS	47.6	3.36	48.8	3.42	0.004($p<0.05$)	
Group B	SWM	6.70	0.67	4.83	0.55	0.003($p>0.05$)	Paired t-test
	BBS	35.4	5.55	46.4	6.27	0.011($p<0.05$)	

Table shows that in within group analysis both groups showed significant improvement in sensation and balance ($p<0.05$).

Table 3: Between group comparison of differences of means

Outcome measures	Group	Pre-test score		Post-test score		P-value	Applied test
		Mean	SD	Mean	SD		
SWM	Group A	5.93	1.07	5.20	1.07	0.009($p<0.05$)	Independent sample t-test
	Group B	6.70	0.67	4.83	0.55		
BBS	Group A	47.6	3.36	48.8	3.42	0.001($p<0.05$)	Independent sample t-test
	Group B	35.4	5.55	46.4	6.27		

Table shows that in between group analysis the group B showed more significant improvement than group A in both outcomes sensation and balance.

DISCUSSION:

The balance impairment and altered sensation is a common symptom of diabetic polyneuropathy. Manage this impairment is important to improve physical function.

The present study examined the effect of multisensory exercise training on sensation and balance in patients with diabetic neuropathy. The SWM and BBSwere used to check sensation and balance respectively.

Intra group analysis showed improvement in balance and sensation in both groups. Inter group analysis showed interventional group showed significant improvement in balance and sensation as compare to conventional group.

Improvement in balance due to visual, somatosensory and proprioceptive stimulus, the proprioceptive information from the joint receptors passes through the Spinocerebellar tracts and reach cerebellum which is a chief controlling organ for balance. The somatosensory input given will increase the sensitivity of the receptors there by balance is improved.

Muscles consume oxygen quickly during exercise, and the amount of oxygen in the tissue decreases. In the absence of oxygen, the arteriolar wall cannot continue to contract, and lack of oxygen causes the release of vasodilators. This causes vasodilation of local arterioles so that all capillaries are open and blood flow increases and decrease blood glucose and improve sensation [17].

Nizar Abdul Majeed Kutty; et al, conducted study, for 6 weeks, both groups were given health education on diabetes for 30 minutes a week. In addition, the experimental group practised a multisensory exercise programme for 30 minutes, 3 times a week over 6 weeks. The study showed that multisensory exercises could improve balance in persons with Type 2 diabetes [18].

Monireh asadi ghaleni; et al, conducted study, in this study 30 elder women randomly assigned into multisensory training and control group. Multisensory training includes balance training with eye open and eye closed on different surfaces to stimulate visual, proprioception and vestibular system. The intervention was collected 12 weeks, two times per week. This Multisensory training program improve the dynamic and static balance in older women [18].

Result showed that multisensory group showed more significant improvement than conventional therapy.

CONCLUSION

After 4 weeks of multisensory exercise training improve balance and sensation in patients with diabetic neuropathy as compare to conventional therapy.

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