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Effectiveness of Task Oriented Training on Activity Specific Balance, Proprioception and Lower Limb Function in Patients with Diabetic Neuropathy

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ABSTRACT

Introduction: Diabetes Mellitus is a chronic metabolic disease wherein there is inadequate control of blood levels of glucose. Regardless of the specific type of diabetes, complications involve: microvascular, macrovascular, and neuropathic. Diabetic neuropathy leads to loss of sensation in their feet, burning or shooting pain in the lower extremity, sores, ulcers, and infections due to impaired sensations. Nerve damage also leads to increase problems with balance and coordination, leading to increased risk of fall.
Method: In this study total 30 patients of diabetic neuropathy were selected and were trained with the task-oriented training protocol for 4 weeks. Pre and post activity specific balance, proprioception and lower limb function were assessed using Activity Specific Balance scale, Distal Proprioceptive Test and Lower Limb Function Scale.
Results: Activity specific balance, Proprioception and lower limb function significantly improved ($p < 0.0001$). Analysis showed that Task oriented Training was effective in improving the Activity specific balance, Proprioception, and lower limb function in Diabetic Neuropathy patients.
Conclusions: The Task oriented training program designed for the Diabetic Neuropathy patients to improve Activity Specific Balance, Proprioception and Lower Limb Function has proven to be effective.

Keywords: [Diabetic neuropathy, task-oriented training, lower limb function, Activity Specific Balance, Proprioception, Balance]

INTRODUCTION

Diabetes mellitus is a chronic metabolic disease characterized by hyperglycaemia due to defective insulin secretion, insulin absorption or both.(1) Pathogenesis of Diabetes include the range from autoimmune destruction of the beta-cells of the pancreas with consequent insulin deficiency to abnormalities that result in resistance to insulin action.(1)This results in deficits of insulin action on target tissues causing abnormality in carbohydrate, fat and protein metabolism.(1) Symptoms of marked hyperglycaemia include polyuria, polydipsia, weight loss, sometimes with polyphagia, and blurred vision. (1)There are mainly 2 types of Diabetes mellitus: A] Type 1 diabetes also known as insulin dependent diabetes mellitus (IDDM) B] Type 2 diabetes also known as non-insulin dependent diabetes mellitus (NIDDM)TYPE 1 : Type 1 diabetes mellitus (T1DM), also known as autoimmune diabetes, is a chronic disease characterized by insulin deficiency due to pancreatic β-cell loss and leads to hyperglycaemia.(2) The

age of symptomatic onset is usually during childhood or adolescence, symptoms can sometimes develop much later.[2]TYPE 2 : Type 2 diabetes mellitus (T2DM), the cause is a combination of resistance to insulin action and an inadequate compensatory insulin secretory response.[1] It is characterized by insulin insensitivity as a result of insulin resistance, declining insulin production, and eventual pancreatic beta-cell failure. This leads to a decrease in glucose transport into the liver, muscle cells, and fat cells. There is an increase in the breakdown of fat with hyperglycaemia. The involvement of impaired alpha-cell function has recently been recognized in the pathophysiology of type 2 DM.[3] _Long-term complications of diabetes include: Retinopathy with potential loss of vision; Nephropathy leading to renal failure; Peripheral Neuropathy with risk of foot ulcers, amputations, and Charcot joints; Autonomic neuropathy causing gastrointestinal, genitourinary, and cardiovascular symptoms and sexual dysfunction.[1] Patients with all forms of diabetes of sufficient duration, including insulin-dependent diabetes mellitus (IDDM) and non-insulin-dependent diabetes mellitus (NIDDM), are vulnerable to these complications, which cause serious morbidity.[4]Type 2 diabetes is characterized by reduced sensitivity to the action of insulin and an inability to produce sufficient insulin to overcome this "insulin resistance". (Davidson's principles and practice of medicine , 23rd edition, 2018)Type 2 diabetes mellitus (DM) is a chronic metabolic disorder in which prevalence has been increasing steadily all over the world.[3] It is predicted that the prevalence of DM in adults of which type 2 DM is becoming prominent in developing countries where the majority of patients are aged between 45 and 64 years.[3]Type 2 DM is due primarily to lifestyle factors and genetics. A number of lifestyle factors are known to be important to the development of type 2 DM.[3] These are: Physical inactivity, Sedentary lifestyle, Cigarette smoking, Generous consumption of alcohol [3] Medical management of diabetes is: Patient education, diet and lifestyle modification, weight management, regular exercising, anti-diabetic drugs, insulin therapy, self-assessment of glycemic control." (Davidson's principles and practice of medicine, 23rd edition, 2018)Diabetic peripheral neuropathy (DPN) is a well-known microvascular complication of type 2 diabetes mellitus attributed to chronic hyperglycemia, and is defined as the presence of peripheral nerve dysfunction in diabetics after exclusion of other causes.[5]Among the complications of diabetes, a group of clinical syndromes caused by damage to the peripheral and autonomic nervous systems are by far the most prevalent.[6] Types of Diabetic Neuropathy include: 1.SOMATIC DIABETIC NEUROPATHY: Polyneuro-pathy (symmetrical, asymmetrical), Mononeuropathy (mononeuritis multiplex) 2.VISCERAL (AUTONOMIC): The most common form of diabetic neuropathy - distal symmetric polyneuropathy[6] Distal symmetric polyneuropathy manifests with a 'stocking and glove' distribution, whereby the hands and lower limbs are commonly affected.[6]Most of the patients of diabetic peripheral neuropathy patients suffer from muscle weakness, loss of sensations, pain, loss of balance, and lower limb dysfunction. As a result, their daily activity and Life satisfaction are gradually impaired. [7] Patients of peripheral neuropathy caused by diabetes often experience balance disorder. Postural sway in these patients is increased, especially with the eyes closed.[8] Peripheral neuropathy caused by diabetes causes significantly impaired sensation in the feet, reducing patients' ability to control their balance properly during daily activities. Poor balance can be due to proprioception impairment.[8] Balance problems are also caused by movement-strategy impairment, biomechanical structural disorders, and disorientation. Postural instability caused by peripheral neuropathy[8] .

In the task-oriented approach, movement emerges as an interaction between many systems in the brain and is organized around a goal and constrained by the environment (Shumway Cook & Woollacott 2001). Task related training (TRT) is a rehabilitation strategy that involves the practice of goal-directed, functional movements in a natural environment to help patients derive optimal control strategies for alleviating movement disorders.[9]In a Task oriented training program, the patient is required to work in a task-specific or self-driven or goal-driven activity.[9]Studies with stroke populations have shown that Task oriented training with specific strengthening exercises for paretic muscles improve locomotion, lower limb weight bearing in sitting, and standing up.[9]In task related training, gait and gait-related tasks are practiced using a functional approach.[9]Task-oriented training includes a wide range of interventions such as treadmill training, walking-training on the ground, bicycling programs, endurance training and circuit training, sit-to-stand exercises, and reaching tasks for improving balance.[9]Difficulties in walking of Diabetes Neuropathy (DN) patients results in higher risk of falling and injuries[10]. Hence the task-oriented training approach will help the patients of diabetic neuropathy to achieve greater confidence while doing the activities of daily living without the fear of falling.

As the prevalence of Diabetes is high in Indian population, it is observed that the people suffer from the late complications of Diabetes. One of the complications is DIABETIC NEUROPATHY. Diabetic neuropathy is a progressive damage to the peripheral nerves, usually begins as mild sensory symptoms of pain or paraesthesia. The problems faced by the patients are pain, paraesthesia confined to distal most part of the extremities. Altered sensations are present in foot and distal leg area and very rarely hand and wrist. Ankle jerks are usually affected due to involvement of sensory fibers of reflex pathways. The general physiotherapy management given is-1) pain relief by TENS conventional mode, 2) care of anesthetic foot, 3) prevention of postural hypotension – elastic stockings for lower limb to prevent peripheral pooling of blood. Researches done on the stroke patient treated with task-oriented training has proven that it increases the static as well as dynamic balance of the patient. But there is scarcity of research of task-oriented training on diabetic neuropathy patients for balance training. Therefore, the purpose of this study is an effort to find the effectiveness of task-oriented training on activity specific balance, proprioception, lower limb function in patients with diabetic neuropathy.

MATERIALS & METHODS

Experimental study was done for 4 weeks (3 days/week) on 30 patients. Study was approved by the ethical committee. Patients were selected according to the inclusion and exclusion criteria. The nature of study was explained and written consent was obtained from the patients prior to the study. Pre-training balance was assessed with the help of outcome measure – activity specific balance confidence scale, Pre-training proprioception was assessed by proprioception awareness, Pre-training lower limb function was assessed by outcome measure – lower limb functional scale.

Inclusion criteria:

1) 1)Age: 40 to 70 (Davidson's principles and practice of medicine, 23rd edition, 2018)
2) 2)Both the genders
3) 3) Activity specific balance score (>60%)
4) 4) Lower limb functional scale score (>/=50)
5) 5) Distal proprioception test score (>/=3)

Exclusion criteria:

1) Any other neurological conditions.
2) Any cardiovascular conditions

3) Any musculoskeletal injuries such as fractures, ligament injuries.
4) Uncontrolled diabetes.
5) Any motor and sensory loss other than due to diabetes

Task oriented Training Protocol:

It incorporated the activities of daily living involving task-oriented activities. The training session was conducted for 1 hour for each patient per day. 1 hour was divided into 10-15 minutes warm-up, 25-30 minutes of exercise training, 10-15 minutes of cool-down.

The protocol was started with warm up consisting of basic all joints range of motion exercises, stretching of the important muscle groups for 10 to 15 mins.

EXERCISES TO IMPROVE BALANCE:

The exercises were given with support first and then were progressed to without support.

a) Lifting and maintaining the lower extremity
b) Lifting only the heels
c) Lifting the lower extremity over the foot stool and then placing it back to the original position
d) Lifting the lower extremity (hip 90^0, knee $90^{0)}$ and then placing it onto the foot stool
e) Step-ups and down
f) Kicking a ball
g) Standing with wide base of support and then decreasing it as if standing with feet close and in tandem standing.
h) Tandem walking

EXERCISES TO IMPROVE PROPRIOCEPTION:

Ambulation exercises: Promotion and assistance with dynamic balance (walking) to maintain or restore the confidence of independent walking, movement and to improve proprioception.

a) Walking back and forth from the start point to the end point at a constant pace (3m to 10m)
b) Stand up and walk, sit down and again continue
c) Obstacle course (chairs, tables, cones etc.)
d) d)Walk and carry
e) Speed walking
f) Walking backwards
g) Walking on stairs
h) Walking on uneven surfaces
i) Walking with rhythmic auditory cues (on music)

Progress was assessed as required, such that the level of difficulty, complexity and dosage (number of repetitions) matched the ability of each individual. The number of repetitions and intensity of the exercises were determined based on patient's performance. The intensity was increased by introducing one or several of the following changes:

- Reducing the base of support
- Increasing the repetitions
- Increasing the hold time
- Changing the base of support
- Blocking the visual cue

Post-training balance was assessed with the help of outcome measure – activity specific balance confidence scale, post-training proprioception was assessed by proprioception awareness, post-training lower limb function was assessed by outcome measure – lower limb functional scale.

DATA ANALYSIS AND RESULTS

The present study aimed at finding the effect of task-oriented training on activity specific balance, proprioception, and lower limb function in diabetic neuropathy patients after 4 weeks protocol.

The data was analysed using Microsoft excel sheet and GraphPad.com. Total 30 patients, both male (16,53%) and female (14,47%) were selected according to the inclusion and exclusion criteria. Various statistical measures such as mean, standard deviation (SD) and test of significance were utilized to analyze the data. 95% confidence interval was taken into consideration. The

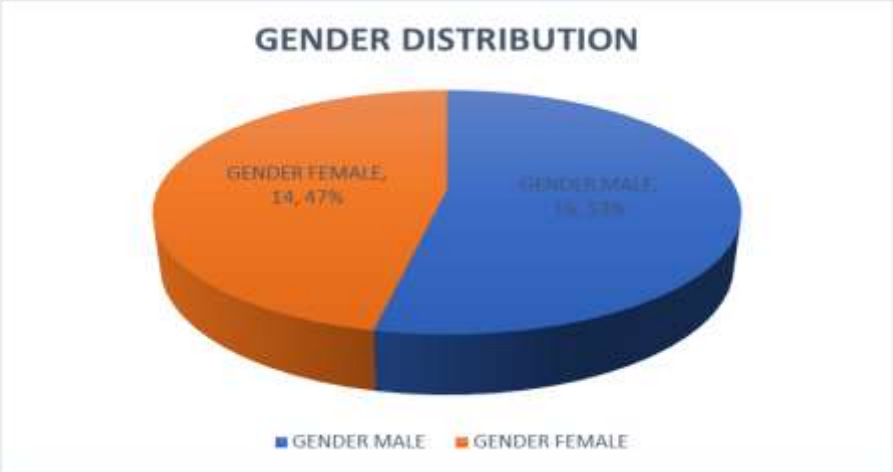
results were concluded to be statistically significant if, p value was <0.05. The data analyzed using paired t test.

There was significant difference (p<0.0001) in pre (48.146 ±7.36) and post (57.791±5.38) activity specific balance scale score, pre (3±0.454) and post (3.333±0.660) distal proprioceptive test score, pre (34.93±13.021) and post (52.32±11.65) lower limb function scale score.

Hence the results showed that task-oriented training was more effective in improving the activity specific balance, proprioception and lower limb function in diabetic neuropathy patients.

I. GENDER DISTRIBUTION

30 patients, between the age group 40-70 years with Diabetic Neuropathy were selected according to inclusion and exclusion criteria and data analysis was done. In the total 30 count, 16 were males and 14 were female.

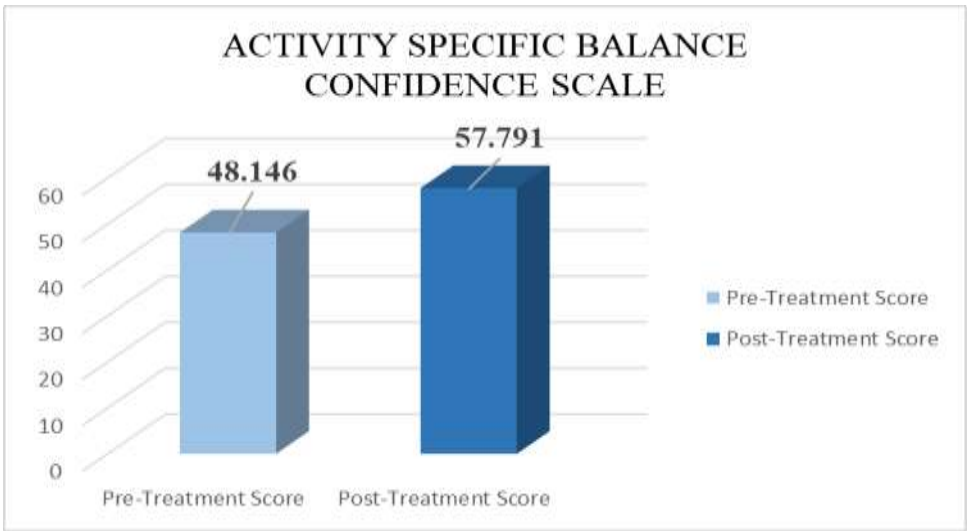


Graph no 1: Gender distribution among the patients

II. ACTIVITY SPECIFIC BALANCE:

Table no 1: Results of Activity Specific Balance

PARAMETERS	PRE-TEST		POST-TEST		T VALUE	P VALUE	RESULTS
Activity Specific Balance	MEAN	SD	MEAN	SD	11.184	<0.0001	EXTREMELY SIGNIFICANT
	48.146	±7.36	57.791	±5.38			

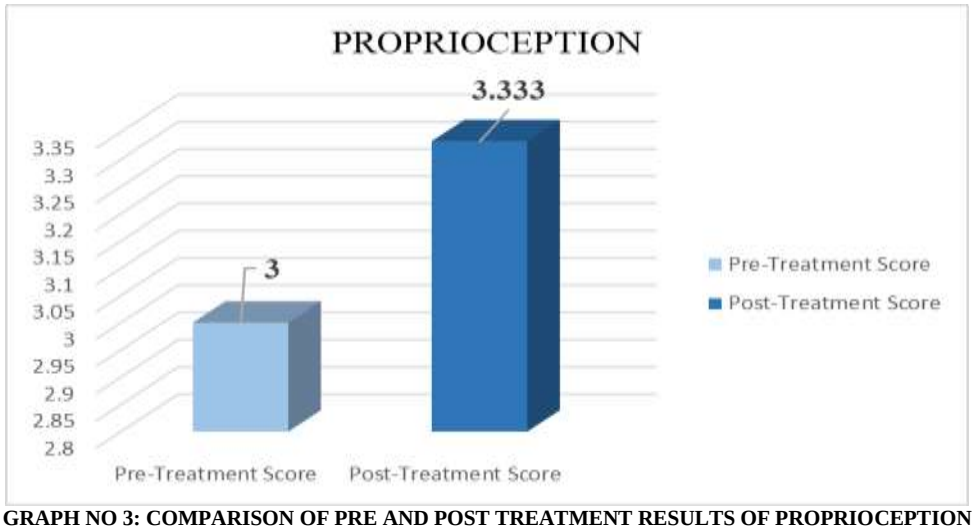


GRAPH NO 2: COMPARISON OF PRE AND POST TREATMENT RESULTS OF ACTIVITY SPECIFIC BALANCE CONFIDENCE

III. PROPRIOCEPTION:

Table no 2: Results of Proprioception

PARAMETERS	PRE-TEST		POST-TEST		T VALUE	P VALUE	RESULTS
Proprioception	MEAN	SD	MEAN	SD	3.808	<0.0001	EXTREMELY SIGNIFICANT
	3	±0.454	3.333	±0.660			

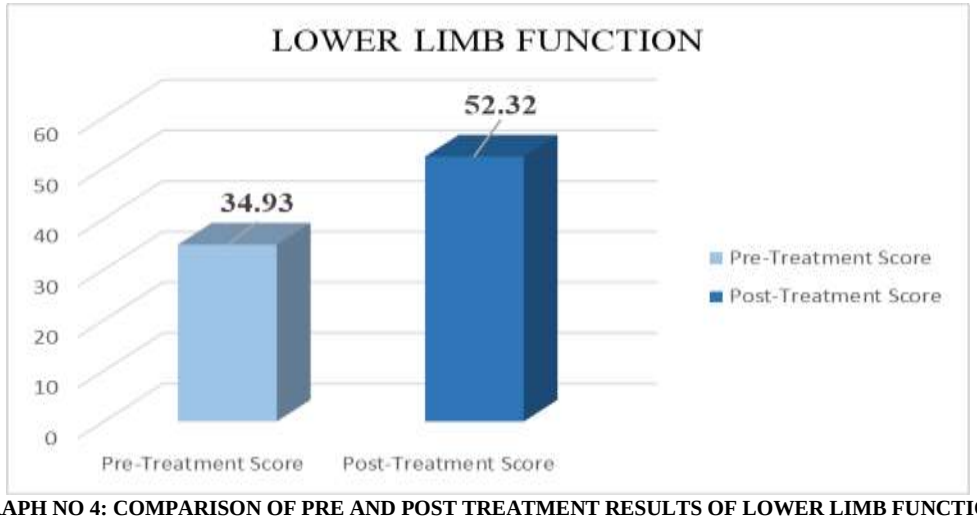


GRAPH NO 3: COMPARISON OF PRE AND POST TREATMENT RESULTS OF PROPRIOCEPTION

IV. LOWER LIMB FUNCTION:

Table no 3: Results of Lower Limb Function

PARAMETERS	PRE-TEST		POST-TEST		T VALUE	P VALUE	RESULTS
Lower Limb Function	MEAN	SD	MEAN	SD	17.545	<0.0001	EXTREMELY SIGNIFICANT
	34.93	±13.021	52.32	±11.65			



GRAPH NO 4: COMPARISON OF PRE AND POST TREATMENT RESULTS OF LOWER LIMB FUNCTION

DISCUSSION

The present study represents potential mechanism associated with response to an intervention that incorporates task-oriented training to improve activities of daily living in patients of diabetic neuropathy. Task oriented training is a rehabilitation strategy that involves the practice of goal directed, functional movements in natural environment to help patients derive optimal control strategies for completion of alleviating movement disorders.

The study showed a statistically significant difference in favour of task-oriented training compared to the conventional physiotherapy treatment.

Three outcome measures were used, namely; activity specific balance confidence scale: to assess confidence in performing various ambulatory activities without falling or experiencing a state of unsteadiness, lower extremity functional scale: to assess the lower extremity function, distal proprioception: to assess the joint position sense and awareness of joints at rest.

Paired t test was used to compare the values of activity specific balance confidence scale, Distal proprioception test, Lower limb function scale before and after treatment, which was extremely significant (p: <0.0001). Thus, the study concluded the effectiveness of Task oriented training on Activity specific balance, proprioception, lower limb function in patients of Diabetic Neuropathy.

The Task oriented training program in present study implementing the functional activities protocol, activities of daily living targeting the lower extremity more than upper extremity designed to improve balance and confidence among the patients with diabetic neuropathy was feasible and exceeds the effectiveness of conventional physiotherapy treatment.

Since, no adverse effects occurred and dropout rates for motivated reasons was none, task-oriented training seemed to be feasible as well as safe and acceptable in the sample of present study.

Diabetic patients who experience peripheral neuropathy and consequent balance problems can achieve better balance and stability through progressive balance training with emphasis on the anterior-posterior neuromuscular elements of stability. (Akbari Mohmmad et al 2012).

Exercise therapy, including balance exercises, leads to increased oxygen pressure in the lower limbs, skin, and chests of diabetic patients, improving skin blood flow. Group exercise therapy is effective in improving balance in older people and reduces the risk of falling. (Akbari Mohmmad et al 2012).

TO motor gait training for DN patients not only enhanced performance during walking, but also modified and improved foot mechanics during walking. Changes in the provided sensorimotor information and enhanced muscle abilities can be regarded as reliable contributions for gait responses in DN patients. Conclusively, gait training with respect to principles of motor learning allowed patients to effectively improve through sessions. (Salsa Bili, Hoda et al 2016).

CONCLUSION

The Task oriented training program designed for the Diabetic Neuropathy patients to improve Activity Specific Balance, Proprioception and Lower Limb Function has proven to be effective.

Clinical Implications:

The study findings are of clinical importance since they indicate an improvement in activity specific balance, proprioception and lower limb function in diabetic neuropathy patients. Diabetic patients can be started with the main diabetic protocol and this task-oriented training together to have maximum advantage at the beginning of the disease which can further lead to good health and fitness of the patient.

Limitations:

Study was done on small population.
Lack of long term follow up.

Future scope of study:

Comparison study can be done between males and females.
Study population can be changed.
Study can be done on larger population.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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