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EFFECT OF PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION (PNF) IN IMPROVING SENSORIMOTOR FUNCTION IN PATIENTS WITH DIABETIC NEUROPATHY AFFECTING LOWER LIMBS

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ABSTRACT

Background: Diabetic Mellitus is a group of metabolic disease characterized by hyperglycaemia resulting from defects in insulin secretion, insulin action or both. Distal Sensorimotor Polyneuropathy is the most common complication of diabetes which mainly affects the lower limbs. Most of the studies aimed at individually increasing muscle strength or sensation but not on overall performance enhancements of the diabetic lower limbs. The evidence supporting the effectiveness of PNF in diabetic neuropathic patients is scarce.

Methods: 30 patients, with age between 50 to 70 years, diagnosed with Diabetic Sensorimotor Polyneuropathy (DSP) were selected from the department of Medicine and department of Neurosurgery Guru Gobind Singh Medical College and Hospital. Patients were evaluated at the beginning and at the end of the intervention using Diabetic Neuropathy Examination scores. Patients received 3 sets of exercises one hour/day with 3 days/week for 3 months. Each set of exercises consists of 5 repetitions of PNF patterns (alternate day) and techniques.

Results: D1 & D2 patterns of PNF are effective in improving both motor and sensory functions of diabetic patients with neuropathic symptoms. Improvement in muscle strength, reflex and sensations occurred to a greater extent after the treatment of three months in these subjects. This study shows that PNF patterns were effective at enhancing sensorimotor problems of lower limbs.

Conclusion: This study concluded that PNF is found to be effective in improving sensorimotor functions of diabetic neuropathic patients affecting lower limbs

Keywords: Diabetes, Diabetic neuropathy, Proprioception Neuromuscular Facilitation (PNF), Diabetic Neuropathy Examination score, Sensorimotor, Polyneuropathy.

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INTRODUCTION

Diabetic Mellitus is a group of metabolic diseases characterized by hyperglycaemia that results from defects in insulin secretion, insulin action on target tissue or both. The chronic hyperglycaemia of diabetes may lead to long-term damage, dysfunction, and failure of various organs, especially the nerves, eyes, kidneys, heart, and blood vessels [1]. According to World Health Organization (WHO), the prevalence of diabetes in 2010 was 5.6% in urban areas and 2.7% in rural areas of India. It is estimated that the total number of people with diabetes in 2010 was around 50.8 million, and is expected to rise to 87.0 million by 2030 [2]. Lots of complications have been associated with diabetes. Neuropathies are one of the most common long term complications of diabetes affecting up to 50% of patients. Diabetic neuropathy is responsible for 50% to 75 % of nontraumatic amputation. This complication of diabetes is associated with considerable morbidity or mortality [3]. Neuropathy is characterised by diffuse damage to the nerves which leads to sensory and motor deficits. These are present in both type 1 and type 2 diabetes. In diabetes, neuropathies tend to affect the longest nerves of the body thus the lower limbs and feet are predominantly affected. Amongst of all the autonomic and somatic neuropathies in diabetes distal or peripheral neuropathies are the most common [4].

Distal Sensorimotor Polyneuropathy is the most common complication of diabetes and its common symptoms are burning pain, electrical or stabbing sensations, paraesthesia, hyperesthesia, deep aching pain and muscle weakness, the symptoms are most commonly experienced in the feet and lower limbs. As a consequence, many people suffering from long-standing diabetes have significant deficits in tactile sensitivity, vibration sense, lower limb Proprioception, and kinaesthesia and absent ankle reflex which further leads to locomotor deficits [5]. Lower limb weakness leads to increased postural sway which increases the risk of falling [6].

Thus keeping in mind the debilitating effects of sensorimotor diabetic neuropathy on lower limbs various physiotherapeutic interventions such as non-weight bearing exercises, sit to stand, stair climbing, toe walking, strength training, swimming and bicycling are recommended for diabetic patients to prevent further deterioration [7]. Most of prior studies aimed at individually increasing muscle strength or sensation but not on overall performance enhancements of the diabetic lower limbs. But recent advancements show that Proprioceptive Neuromuscular Facilitation (PNF) exercises are very similar to the actions and movements found in various activities of daily life [8].

Proprioceptive Neuromuscular Facilitation (PNF) is a form of treatment developed in the 1950's by Herman Kabat. It is the therapeutic intervention which is used to facilitate patient's performance with movement deficits. PNF is one such technique that aims to increase strength, coordination and control of motion, develop proper balance

between motion and stability and to increase endurance through the stimulation of proprioceptors [9].

The patterns of PNF exercises are performed in spiral and diagonal directions, and the performance of these patterns is in line with the topographic arrangement of the muscles being used [10]. There are two separate patterns of diagonal movement for lower limbs which are referred to as the diagonal 1 (D1) and diagonal 2 (D2) patterns. These diagonal patterns are subdivided into D1 moving into flexion, D1 moving into extension, D2 moving into flexion, D2 moving into extension. These patterns include movements of lower limbs and along with sensory stimulation by hands of therapist holding ankle [11].

Various studies have shown the effects of PNF in improvement of movement deficits in many conditions such as multiple sclerosis, cerebral palsy and stroke. But the evidence supporting the effectiveness of PNF in diabetic neuropathic patients is scarce. Thus the purpose of this study is to study the effect of Proprioceptive Neuromuscular Facilitation (PNF) on sensorimotor function in patients with diabetic neuropathy affecting the lower limb.

METHOD

An interventional pre and post test study included a sample of 30 patients through purposive sampling technique. The patients previously diagnosed with Diabetic Sensorimotor Polyneuropathy were selected for the study. The patients were referred from Department of Medicine and Neurosurgery, GGS Medical College and Hospital Faridkot. Informed consent was obtained from each participant. The ethical approval was given by Research and Ethical committee of University College of Physiotherapy. The study was conducted at University College of Physiotherapy, Faridkot.

The participants had to meet the following inclusion criteria: (1) Age 50-70 years, (2) both male and female patients, (3) patients with Type II Diabetes Mellitus, (4) patients with complications of Distal Symmetrical Sensorimotor Polyneuropathy, (5) Patients with duration of Diabetes Mellitus since 10 years, (6) patients having a score more than 3 in Diabetic Neuropathy Examination Score.

The participants were excluded if they were diagnosed with musculoskeletal disorders, common peroneal nerve Injury, peripheral vascular diseases, comprehension deficits, visual deficits and other neurological disorders.

Intervention:

In the study, the patients were treated with 3 sets of exercises one hour each day with 10 minutes of rest between each set, for 3 days/week for 3 months. Each set of exercise consists of 5 repetitions of Proprioceptive Neuromuscular Facilitation (PNF) patterns. The patients are treated with these Proprioceptive Neuromuscular Facilitation (PNF) exercises on every alternate day [11].

The Proprioceptive Neuromuscular Facilitation (PNF) patterns of diagonal movement implemented in study were referred to as the Diagonal 1 (D1) and Diagonal 2 (D2)

patterns. These diagonal patterns are subdivided into D1 moving into flexion, D1 moving into extension, D2 moving into flexion, D2 moving into extension (Prentice 2000). The starting and terminal positions, specific movements in the D1 and D2 patterns for the lower extremities are as follows:

D1 Moving into Flexion: The starting position of the toes was flexed and terminal position was extended. The starting position of the ankle and foot was plantar flexed; everted and terminal position was dorsiflexed inverted. The starting position of position of tibia was externally rotated and the terminal position was internally rotated. The starting position of knee was extended and the terminal position was flexed. The starting position of the hip was extended, abducted, internally rotated and the terminal position was flexed, adducted, externally rotated.

D1 Moving into Extension: The starting position of the toes was extended and terminal position was flexed. The starting position of the ankle and foot was dorsiflexed, inverted and terminal position was plantar flexed; everted. The starting position of position of tibia was internally rotated and the terminal position was externally rotated. The starting position of knee was flexed and the terminal position was extended. The starting position of the hip was flexed, adducted, externally rotated and the terminal position was extended, abducted, internally rotated.

D2 Moving into Flexion: The starting position of the toes was flexed and terminal position was extended. The starting position of the Ankle and foot was plantar flexed; inverted and terminal position was dorsiflexed, everted. The starting position of position of Tibia was externally rotated and the terminal position was internally rotated. The starting position of Knee was extended and the terminal position was flexed. The starting position of the hip was extended, adducted, externally rotated and the terminal position was flexed, abducted, internally rotated.

D2 Moving into Extension: The starting position of the toes was extended and terminal position was flexed. The starting position of the Ankle and foot was dorsiflexed, everted and terminal position was plantar flexed; inverted. The starting position of position of Tibia was internally rotated and the terminal position was externally rotated. The starting position of Knee was flexed and the terminal position was extended. The starting position of the Hip was flexed, abducted, internally rotated and the terminal position was extended, adducted, externally rotated.

Outcome Measures:

Patients were examined and evaluated using Diabetic Neuropathy Examination (DNE) scale before starting and after the end of treatment. They were assessed for muscle strength, reflex and sensations.. Trunk Impairment Scale (TIS) was used to assess trunk control. Balance was evaluated by Berg Balance Scale (BBS). Gait speed and cadence was calculated by 10 meter distance walk test. All measurements were taken at the beginning of the study and at end of 3 months.

Data Analysis:

Data was analyzed using SPSS software version 11. Paired t tests were used to check the efficacy of PNF exercises. Paired t test was performed for variable Diabetic Neuropathy Examination (DNE).

RESULTS

Total 30 subjects participated in this study with age group of 50-70 years. Paired t test was done to analyse the significance of difference between the values of DNE (Diabetic Neuropathic Examination) taken before the start of treatment and at end of treatment. The result was considered significant with $p < 0.05$.

Paired t test was applied between the pre test and post test DNE values of diabetic neuropathic patients to analyse the changes in the variables of DNE (muscle strength, reflex, sensations). Comparison of pre and post readings of all the individual variables of DNE was done to test the significance of difference after giving PNF treatment to the patients.

Paired t test was performed on the pre and post values of muscle strength (DNE) of quadriceps and tibialis anterior. The calculated t test value was greater than table value for muscle strength of both quadriceps and tibialis anterior. The results indicates that there was significant improvement in quadriceps strength with p value < 0.05 (Fig. 1) and significant improvement was also seen in tibialis anterior with $p < 0.05$ (Fig. 1).

Comparison between the pre and post values of Achilles reflex and pinprick sensation of index toe had been done. The results indicates that there was significant improvement in Achilles reflex and pinprick sensation with p value < 0.05 (Fig. 2).

Similarly comparison of pre and post treatment values of sensations of Big toe (pinprick, touch, vibration & joint position sense). The results showed that there was no significant difference in pinprick and touch sensations of big toe with $p > 0.05$ (Fig. 3), but the values of vibration perception and joint position sense of big toe showed that there was a significant difference in pre and post value. These two sensations show highly significant improvement with $p < 0.05$ (Fig. 3).

The comparison between pre and post values of DNE collectively (Total DNE) was also done. The results shows that there was a significant improvement in DNE scoring with $P < 0.05$ (Fig. 4).

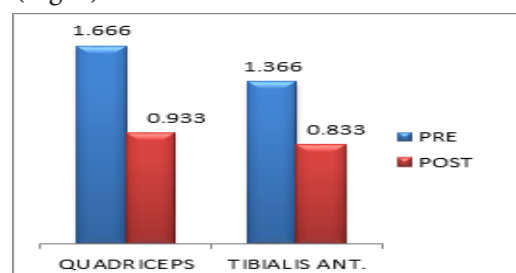


Figure 1: Comparison of pre and post values of reflex and pinprick sensation on DNE

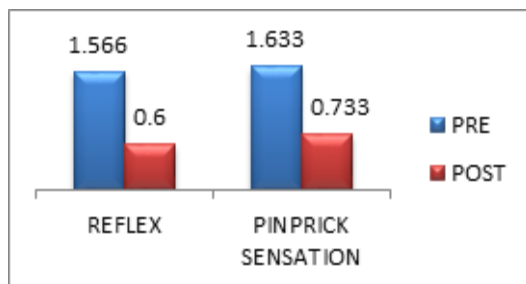


Figure 2: Comparison of pre and post values of quadriceps and Tibialis Anterior strength on DNE

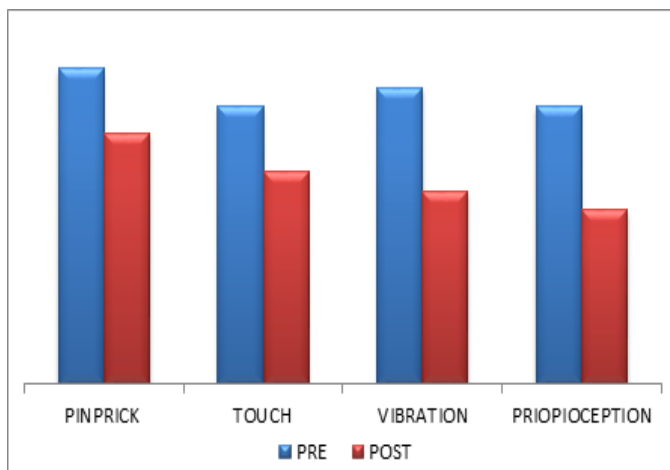


Figure 3: Comparison of pre and post values of sensations of big toe on DNE

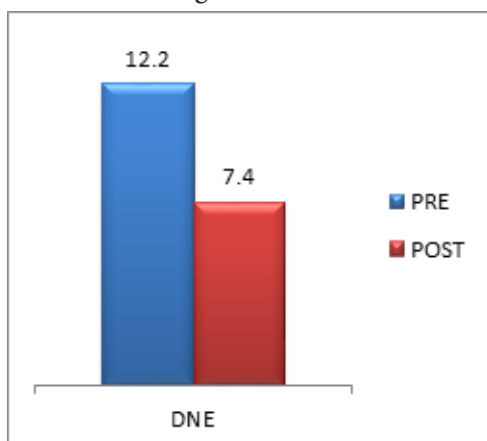


Figure 4: Comparison of pre and post values of DNE (Total)

DISCUSSION

The aim of this study was to find the efficacy of Proprioceptive Neuromuscular Facilitation (PNF) in improving sensorimotor function in patients with Diabetic Neuropathy affecting lower limbs.

The study concluded that D1 & D2 patterns of PNF are effective in improving both motor and sensory functions of diabetic patients with neuropathic symptoms. Improvement in muscle strength reflex and sensations occurred to a greater extent after the treatment of three months in these subjects. This study shows that PNF patterns were effective at enhancing sensorimotor problems of lower limbs.

The results of present study are consistent with other studies which concluded the effect of PNF technique.

A study by Chitra & Das (2015) supports present study. They studied the effect of PNF technique on core strength in patient with type 2 diabetes. The result of the study showed a statistical significance in the core strength ($p < 0.001$). After PNF technique there was significant improvement in core strength in patient with diabetes.

The results of a study by Kumar S (2012) are also found to be relevant with present study. He assessed the effect of PNF techniques on the gait parameters and functional mobility in hemiplegic patients. The PNF techniques helped improving the gait and mobility of these patients by improving sensorimotor function.

The findings of the present study indicate the use of PNF patterns is beneficial in improving the muscle strength and sensations of lower limbs of diabetic patients. Improvements in muscle strength and sensation may be due to the fact that the PNF exercises mainly consisted of spiral or diagonal movement patterns which are close to natural movement patterns of our body. They are designed to recruit the muscles used in natural movements of lower limbs. Thus the pattern and its repetition helped in strengthening of muscles. The improvement in sensory functions may be due to the continuous stimulus provided by the therapist hand while performing the PNF patterns by holding patients lower limbs.

CONCLUSION

This study concluded that PNF is found to be effective in improving sensorimotor functions of diabetic neuropathic patients. Improvement in muscle strength and sensations of lower limbs occurred to a greater extent after the treatment of three months in diabetic subjects. In addition, it is statistically proved muscle strength and sensations improved after treatment with statistical significance of $p < 0.05$. Improvement in patients receiving D1 & D2 patterns of PNF on measures of Diabetic Neuropathic Examination (DNE) score is highly significant with $p < 0.05$. Thus PNF technique is effective in improving sensorimotor functions of diabetic neuropathic patients.

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