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EFFICACY OF PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION FOR IMPROVING BALANCE IN DIABETIC NEUROPATHY

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Abstract: Diabetic Peripheral Neuropathy experiences muscle weakness, loss of ankle reflexes, and decreased balance, coordination and gait control, thereby, limiting walking and increasing the risk of fall-related injuries. Sensory component of peripheral neuropathy causes gradual loss of sensitivity to pain, perception to plantar pressure, temperature and proprioception which can lead to postural instability. Aim of the study is to find out effectiveness PNF to improve strength, & balance in diabetic neuropathy for preventing fall history. An Experimental study was carried out over the period of 3 weeks with total 40 subjects between the age group 50 - 65 years. The subjects were randomly allotted into experimental group (n = 20 ; PNF and Wobble board training) and control group (n = 20 ; Wobble board training alone). Initially and after the intervention, patients were assessed with BBS ; TPOMAS ; Wobble board were used to measure the level of patient's evaluation. Between group analysis shows that experimental is more significant than control group. There is improvement of balance in experimental group (PNF and Wobble board training) than control group (Wobble board training alone). Hence it is concluded that PNF is found to be effective in improving balance and posture in diabetic neuropathic patients to prevent earlier fall history.

Key words : BBS – Berg Balance Scale, TPOMAS – Tinnetti Performance Oriented Mobility Assessment Score.

I. INTRODUCTION

Diabetic neuropathy is defined as "the presence of symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after the exclusion of other causes". (Boulton *et al.*,)[(8)] Diabetic Peripheral Neuropathy experience muscle weakness, loss of ankle reflexes, and decreased balance, coordination and gait control, thereby, limiting walking and increasing the risk of fall-related injuries.(mackne horak)[(39)] Sensory component of peripheral neuropathy causes gradual loss of sensitivity to pain, perception to plantar pressure, temperature and proprioception which can lead to postural instability. (Dingwell JB) [(14)]

DPN is one of the serious known micro vascular complications of both type 1 and type 2 diabetes mellitus [5-7] having been diagnosed in 20-50% of the diabetic population (Tesfaye S).[(58)]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 [mohan]. Prevalence of neuropathy among diabetic patients is 33%. In small towns and villages of India, this was found to be 5.9 % and 2.7 % respectively. (Sadikot)[(54)]

Diabetes has a very high prevalence and a third of the diabetic population is affected with neuropathy. 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 propriception, & kinaesthesia and absent ankle reflex which further leads to locomotor deficits (javed)[26]. Lower limb weakness leads to increased postural sway which increases the risk of falling.(Allet L) [35]

One third of the patients with diabetic peripheral neuropathy (DPN) present with some kind of balance and gait disturbances. (Guariguata)[21] Falls in elderly are associated to both mortality and morbidly increasing. Falls are also the major death cause in people aging over 85 years [h lee][34]. The balance exercises are feasible and safe, to improve balance and gait, consequently, reducing the risk of falls and fall-related injuries. Therefore, balance exercises should be used as a supportive therapy in diabetic peripheral neuropathy patients.(Scartz)[51]

Balance is common problem in diabetic neuropathy. It is seen that balance training with altered sensory input is better compared than without altered sensory input. So this study is directed towards giving balance training with sensory reeducation for improving balance and quality of life in diabetic neuropathy. Reduced balance is affected by decreased vibration sensitivity which triggers imbalance problems and cause injurious accident. Balance is controlled on the basis of afferent information from somatosensory input, visual and vestibular system. The first two systems are often affected in presence of diabetic neuropathy.(Alet et al)[1]

The term 'proprioception' was coined for the first time by Sherrington in 1906. The term is the combination of the Latin words 'proprio' and 'ception'. The word proprio means 'one's own' while the word ception means perception. This way, proprioception can be defined as personalized perception.(Mehmet Gokhtepe)[40] 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. (Kumar)[27] 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 D2 moving into flexion, D2 moving into extension. (Prentice)[15]

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. (Chitra)[12] 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, Dl 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. (Prince)[19]The aim of the study is to find out the effectiveness of PNF in improving strength & balance for preventing fall history in diabetic neuropathy.

Many studies has been done so far to improve the strength and sensation for maintaining the balance in diabetic neuropathic patients but no other study was done with the proprioceptiive neuromuscular facilitation technique as a treatment strategy in improving balance and co-ordination for the diabetic neuropathic patients. So, the purpose of the study is to find out the effectiveness of proprioceptive neuromuscular facilitation to improve posture control and balance thereby preventing the earlier fall history in diabetic neuropathy.

II.RESEARCH METHODOLOGY

2.1 Population and sample

STUDY TYPE : Experimental study
POPULATION : Subjects with Diabetic neuropathy
SETTING : Department Of Physiotherapy, Sri Venkateshwaraa Medical College Hospital & Research Centre, Ariyur, Pondicherry - 605 102
COLLECTION OF DATA : Male and female diabetic peripheral neuropathic subjects who were satisfying the selection criteria .
SAMPLING SIZE : 40 patients
SAMPLING GROUPS : Group A - 20 Patients
Group B - 20 Patients
DURATION OF STUDY : 6 months
DURATION OF TREATMENT : 3 weeks

2.2 Selection criteria:

Inclusion Criteria:

1. Patient with diabetic neuropathy.
2. Patient with age group of 45-65 will be included in this study.
3. Both male and female included.
4. Patient having diabetes since 5 - 10 years.
5. Patient having both sensory and balance impairment.

Exclusion Criteria:

1. Foot ulcer at the moment of intake.
2. Patient with orthopedic problems influencing gait.
3. Patient with neurological problems influencing gait parameters.
4. Non diabetic neuropathy, and other neurological pathologies (other than PN) could influence gait variables.
5. Impairment without correction, recent complaints of dizziness or falls were also excluded from the study.

2.3 Outcome measures:

- Berg balance scale
- Tinnetti performance oriented mobility

III.PROCEDURE :

Patient who fulfilled the inclusion criteria were included for the study. The benefit of the study and treatment intervention will be explained to the patient and a written informed consent was taken. The subject will be assessed using single leg stance test for balance. Here balance exercises were used as a conventional therapy for both groups. The patients were allocated randomly into 2 groups consisted of 20 patients each.

GROUP A : PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION:

- D2 Flexion pattern for lower limb: 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 and 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.

Fig .1 : PNF for Lower limb in D2 Flexion

Fig.2 :PNF for Lower limb in D2 Extension

GROUP B :BALANCE TRAINING :

A 5- minute warm-up before the activity included short walks and games with balls, using hands or feet. Participants were asked to walk forwards, backwards, and sideways, with eyes both open and closed, at different speeds and for various distances.

The exercises included

Exercise-1: Performing double-legged stance for 10 seconds.
Exercise-2: Performing tandem stance for10 seconds.
Exercise-3: Performing single legged stance for 10 seconds.
Exercise-4: Raising heels in the standing Position.
Exercise-5: Raising toes in the standing position.
Exercise-6: Weight shifting Exercise.
Exercise-7: The subjects maintaining balance on both feet will perform small knee bends to change balance.

Fig 3: Double leg stance

Fig 4: Toe raise

Fig 5 : Heel raise

Fig 6 : Single leg stance

IV. STATISTICAL ANALYSIS :

The outcome values obtained were manually calculated.

In this study, to find out the effect of PNF training to improve balance in Diabetic Peripheral Neuropathy was found by comparing the significant different between experimental and control group. The pre-test and post-test interventional differences within the two group were analyzed using paired 't' test for outcome measures. Statistical significance was set at $p<0.01$ was considered as a significance difference. The effects of intervention on the changes from pre to post test values within the groups were analyzed using the paired 't' test and the unpaired 't' test were used for between the group analysis of pre & post values respectively.

WITHIN THE GROUP ANALYSIS OF BERG BALANCE SCALE :

Table 1 : Showing the pre and post-test values of group A : (paired t-test values)

GROUP-A	Mean	SD	t-value	p-value
Pre test	23.13	2.10	35.63	0.0001
Post test	49.60	2.87		

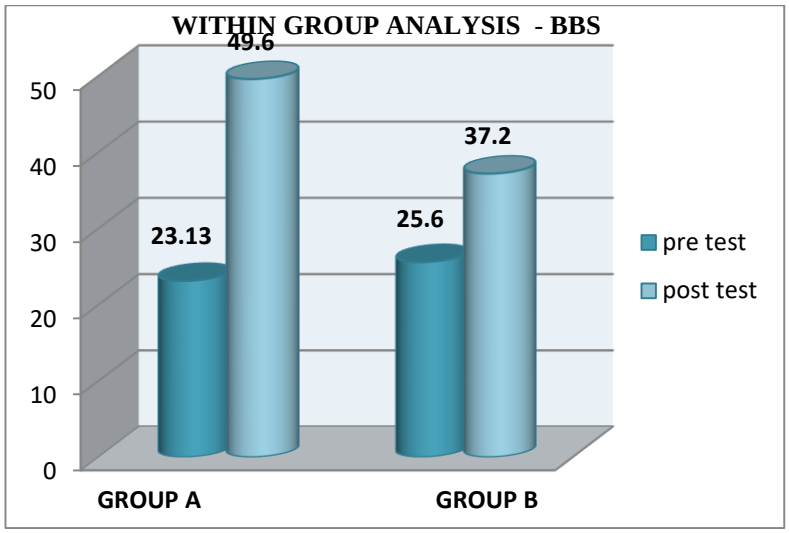
The 'p' value of Berg balance scale for GROUP A is <0.0001considered to be more significant.
The 't' value of for Berg balance scale GROUP A is 35.63 with 14 degree of freedom.

Table 2 : Showing the pre and post test values of both Group B (paired 't' test – values)

GROUP –B	**Mean**	**SD**	**t-value**	**p-value**
Pre test	**25.60**	**2.79**	**12.08**	**0.01**
Post test	**37.20**	**2.48**		

The 'p' value of for Group B is <0.01, considered to be significant.
The 't' value of for Group B is 12.08 with 14 degree of freedom.

Graph - 1: Within the group analysis of pre and post test values of Berg Balance Scale



The pre and post test values of Group A shows the significant improvement in increasing the balance than the pre and post test values of Group B ($p<0.01$).

WITHIN GROUP ANALYSIS OF TINNETTI PERFORMANCE ORIENTED MOBILITY ASSESSMENT

Table 3 : Showing the pre and post-test values of group A

GROUP – A	Mean	SD	t-value	p-value
Pre test	12.47	1.30	21.59	0.0001
Post test	20.20	1.01		

The 'p' value of Tinetti performance oriented mobility assessment for GROUP A is <0.0001considered to be significant.

The 't' value of for Tinnetti performance oriented mobility assessment GROUP A is 21.59 with 14 degree of freedom.

WITHIN GROUP ANALYSIS OF TINNETTI PERFORMANCE ORIENTED MOBILITY ASSESSMENT

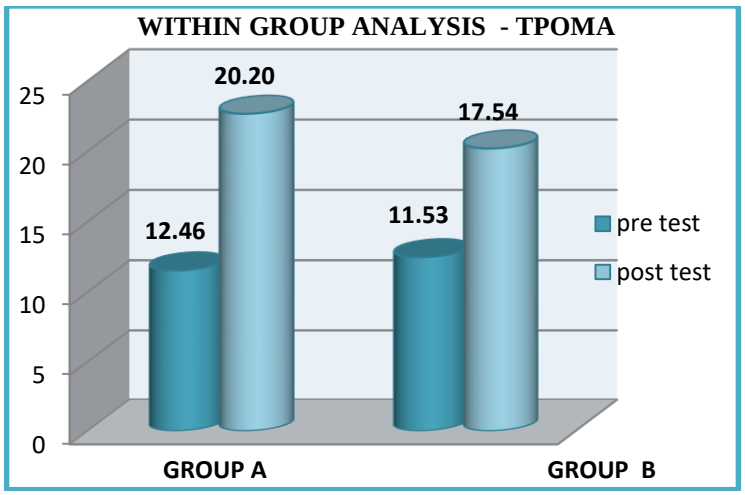
Table 4 : Showing the pre and post-test values of group B

GROUP - B	Mean	SD	t-value	p-value
Pre test	11.53	1.20	18.39	0.0001
Post test	17.54	1.07		

The 'p' value of Tinnetti performance oriented mobility assessment for GROUP B is <0.0001considered to be significant.

The 't' value of for Tinnetti performance oriented mobility assessment GROUP B is 18.39 with 14 degree of freedom.

Graph - 2: Within the group analysis of pre and post test values of Tinnettti performance oriented mobility assessment



The pre and post test values of Group A shows the significant improvement in increasing the balance than the pre and post test values of Group B ($p<0.01$).

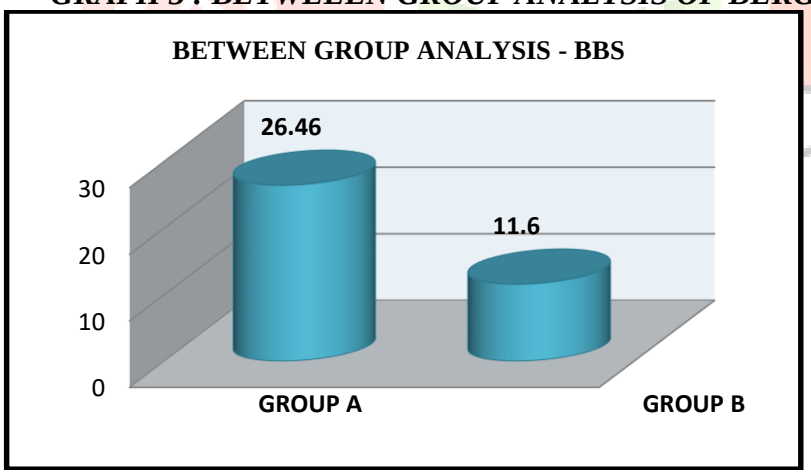
BETWEEN THE GROUP ANALYSIS OF BERG BALANCE SCALE :

Table 5: Showing the pre and post-test values of group A &B : (unpaired t-test values)

GROUP – A & B	Mean	SD	t-value	p-value
Pre test	10.26	3.326	11.8312	0.01
Post test	1.66	0.6012		

The 'p' value of Berg balance scale is <0.01 considered significant.
The 't' value of Berg balance scale is 11.8312 with 28 degree of freedom

GRAPH 3 : BETWEEEN GROUP ANALYSIS OF BERG BALANCE SCALE



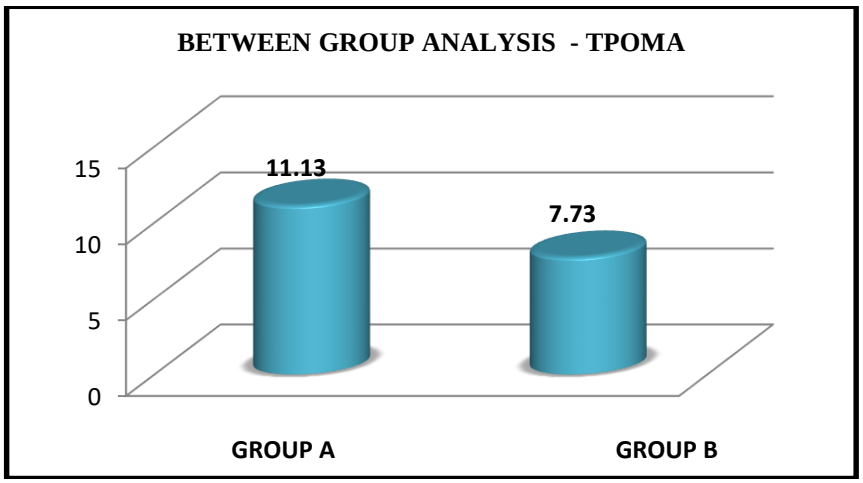
BETWEEN THE GROUP ANALYSIS OF TINNETTI BALANCE SCORE:

Table 6 : Showing the pre and post-test values of group A &B : (unpaired t-test values)

GROUP – A & B	Mean	SD	t-value	p-value
Pre test	9.74	2.126	5.115	0.01
Post test	2.66	0.6034		

The 'p' value of Tinnetti balance scale is <0.01considered significant.
The 't' value of Tinnetti balance scale is 5.115 with 28 degree of freedom.

GRAPH 4 : BETWEEEN GROUP ANALYSIS OF TPOMA



V. RESULT

The mean and standard deviation of pre and post values of Berg balance scale

Within the Group analysis of Group A & B:

For Experimental group the mean and SD for Berg balance score, pre and post values is 23.13 ± 2.09 and 49.60 ± 2.87 and t value is 35.63. The statistical analysis is done with paired "t" test within experimental group shows more significant ($p<0.0001$).

For control group the mean and SD for Berg balance score is 25.6 ± 2.79 and 37.2 ± 2.48, and t –value is 12.07. The statistical analysis is done with paired "t" test within the control group shows significant ($p <0.01$).

Within the group analysis, it has been shown that the pre and post test values of berg balance scale shows significant improvement in experimental group than the control group.

The mean and standard deviation of pre and post values of Tinnetti balance score .

Within the Group analysis of Group A & B:

For Experimental group the mean and SD for tinnetti balance score, pre and post values is 12.46 ± 1.30 and 20.20.60 ± 1.01 and t value is 21.58. The statistical analysis is done with paired "t" test within experimental group shows more significant ($p<0.0001$).

For control group the mean and SD for Tinnetti balance score is 11.53 ± 1.20 and 17.54 ± 1.08, and t –value is 18.39. The statistical analysis is done with paired "t" test within the control group shows significant ($p <0.01$).

Within the group analysis, it has been shown that the pre and post test values of berg balance scale shows significant improvement in experimental group than the control group.

Between the Group analysis of Group A & B:

The mean and SD for the Berg balance scale is 10.26 ±3.326 and 1.66 ± 0.612 and "t" value is 11.312. The statistical analysis done with unpaired t test with the experimental and control group analysis shows significance ($p< 0.01$).

The mean and SD for the Berg balance scale is 9.74 ±2.126 and 2.66 ± 0.6034 and "t" value is 5.115. The statistical analysis done with unpaired t test with the experimental and control group analysis shows significance ($p< 0.01$).

Between group analysis that post values shows that experimental is more significant than control group after statistical analysed, it has been there is improvement of balance in experimental group (Proprioceptive neuromuscular facilitation and Wobble board training) than control group (Wobble board training alone).

This shows that the experimental group A is significant than the control group B.

VI. DISCUSSION

The biggest problem in diabetic peripheral neuropathy is fall risk which is common among diabetic patients. This study was aimed to assess the effects of PNF and balance training among 45 – 60 years of old age people with diabetic peripheral neuropathy.

This was an experimental study conducted to find out the effectiveness of Proprioceptive neuromuscular facilitation in improving balance for the diabetic neuropathic patients. The Most of the patients were affected by balance due to decrease in proprioception and sensation. Here 40 subjects were selected on the basis of selection criteria and divided into two groups as "Group A – Experimental group" (n=20; Proprioceptive neuromuscular facilitation) and "Group B – Control group" (n=20 ; Balance training).

The outcome measures used to assess the balance are "Berg balance scale" and "Tinnetti performance oriented mobility score".

The statistical analysis was carried out using paired t test. Both the groups showed improvement in the balance and performance done by the treatment sessions. Unpaired t test showed that the balance and posture improvement is significantly higher in group A than compared to group B.

This study was supported by **Irshad Ahmed et al,** they result showed that the "Balance Training in Diabetic Peripheral Neuropathy" had improvement in balance performance scales like Berg balance Scale (BBS).

The result of this study shows statistically improvement on balance and posture which correlates the study of **"Chaitali et al (2016)"** which shows "Effects of sensory training over two different surfaces on balance and gait in persons with diabetic neuropathy".

Sterivon Morrison et al (2010) observed the following balance training in diabetic group showed significant improvement in proprioception, decreased sway and reduce fall risk. This study correlates with present study which helps to improve proprioception , balance and postural control in diabetic neuropathy patients.

Salsabili *et al.* 2011 shows the improved proprioception and muscle strength. Salsabili and colleagues observed better balance performance after balance training in patients with DN which was independent of the severity of the neuropathy.

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 patients. The PNF techniques helped improving the gait and mobility of these patients by improving sensorimotor function.

PNF exercises mainly consist of diagonal movement patterns which are close to natural movement patterns of our body. The present study indicates that PNF approach is beneficial in improving the muscle strength and sensations of lower limbs of diabetic neuropathy patients. Thereby it improves the balance for the diabetic neuropathic patients to reduce the fall history.

VII. CONCLUSION

The present study concluded that proprioceptive neuromuscular facilitation is found to be effective in improving balance and posture in diabetic neuropathic patients to prevent earlier fall history.

VIII. LIMITATIONS & RECOMMENDATIONS

LIMITATIONS :

- The treatment session and study duration was limited to three months.
- Older age groups were not included.

RECOMMENDATIONS :

- Alterations of liable surfaces were included in further studies to find out to improve balance thereby reducing the fall history in older adults.
- Futures studies should include electromyographic analyzes during the balance test to determine the cause of enhancement of dynamic balance control.

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