IJRAR.ORG E-ISSN: 2348-1269, P-ISSN: 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | IJRAR.ORG

An International Open Access, Peer-reviewed, Refereed Journal

EFFECTIVENESS OF TACTILE CUES ALONG WITH ANKLE PROPRIOCEPTION TRAINING TO IMPROVE BALANCE AMONG DIABETIC PERIPHERAL NEUROPATHY PATIENTS

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ABSTRACT

AIM AND OBJECTIVE OF THE STUDY:

To investigate whether incorporating tactile cues into ankle proprioceptive training enhances balance among diabetic peripheral neuropathy patients.

BACKGROUND OF THE STUDY:

Diabetes related peripheral neuropathy substantially impairs somatosensory function, which makes it harder for the patient to maintain adequate balance while engaging in everyday activities. Patients with diabetic neuropathy may have abnormalities in their proprioceptive and foot sensations, which are two crucial components of static balance.

METHOD:

The purpose of the study was explained to the patients, and they signed a prior informed consent form. The patients were assessed using the Toronto Clinical Neuropathy Scale, and their balance and functional mobility were evaluated using the Timed Up and Go Test. In this study, fifty people of both sexes are divided into two groups at random. For a period of twelve weeks, three days a week for up to forty-five minutes, one group underwent ankle proprioception exercise with tactile cues, whereas the other group only underwent proprioception exercises.

RESULT:

TUG test Post test value of group A is 10.48 ± 1.159 and group B is 13.96 ±1.989 Group A had better mean reduction in TUG test (7.20) than Group B TUG test (3.96) and this was found to be statistically significant. Each group shows improvement in interventions but the magnitude of the improvements in balance was greater in GROUP A (ankle proprioceptive training along with tactile cues) compared to GROUP B (ankle proprioceptive training).

CONCLUSION:

The study findings suggest that ankle proprioceptive training combined with additional tactile cues produces considerable improvement in the balance in DPN patients compared to proprioceptive training alone. This combined training lowers the chance of falling, and increases quality of life and functional mobility.

Introduction

Diabetes mellitus (DM) is a chronic metabolic condition that is associated with chronically high blood sugar levels, often called hyperglycaemia. Total of 415 million people aged 20 to 79 had diabetes mellitus in 2015, according to the International Diabetes Federation (IDF). Diabetes mellitus is proven to be a global public health burden, with another 200 million anticipated to be added by 2040. [1] The main sub-types of diabetes mellitus are type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM), which are classified based on insulin secretion (T1DM) or insulin resistance (T2DM).

Around ninety percent of incidents of diabetes mellitus are type 2 diabetes. The reduced sensitivity to insulin in type 2 diabetes is referred to as insulin resistance. The body first generates more insulin to maintain glucose homeostasis since insulin is insufficient in this scenario, but over time, this production decreases, leading to type 2 diabetes. The most common diagnosis of T2DM is made after the age of 45. But because of increased rates of obesity, inactivity, and calorie-dense meals, it is more common among kids, teens, and young adults. [2] T2DM often manifests later in life, yet juvenile obesity has contributed to an increase in type 2 diabetes mellitus in young populations. [3]

Type 2 diabetes is extremely common in India –among the highest rates worldwide. Number of Indian with T2DM is predicted to reach close to one million by 2030. [4]

Globally, non- communicable illnesses were behind 74% of deaths in 2019, according to World Health Organization (WHO). 2019 had 1.6 million fatalities globally from diabetes, making it the tenth leading cause of mortality. In low- and middle-income nations, the prevalence of diabetes is increasing at the fastest rate. [5]The most frequent complication of both type 1 and type 2 diabetes, diabetic peripheral neuropathy, affects more than half of those who have it.[6]

The prevalence of DPN increases with age. From five percent (3.1-6.9%) in the 20-29 demographic to 44.2% in the 70-79 age group. In people who had diabetes under five years, neuropathy was identified in 20.8% of cases, but for those with diabetes over ten years, it was in 36.8%. [7]

Deceptively, peripheral neuropathies start with decreased sensitivity and progress to motor nerve dysfunction a distal to proximal pattern. Paraesthesia, hyperaesthesia and deep agonizing pain are among the symptoms that about 50% of patients may suffer. Diabetes causes sensory disturbance, which causes loss of vibration, pressure, warmth and discomfort. Proprioception is also affected, and reflex reaction time is lengthened. Additionally, up to 30% of DPN suffer reported loss of ankle reflexes, weak muscles and an impaired balance, gait control and coordination. Walking and other activities are restricted by all these risk factors, which also raise the frequency of injuries caused by falls. [8]

This complication develops because of the harmful effects of hyperglycaemia. It is often marked by substantial abnormalities in tactile sensitivity, vibration sensation, lower-limb proprioception and kinesthesis. Painful DPN has been linked to severe losses in overall quality of life, increased levels of anxiety and depression, sleep impairment and increased gait unpredictability.

Poor balance and increased falling risk have been reported in people with DPN due to decreased superficial and deep sensory feedback. [9] Proprioceptive training improves leg and ankle balance, and proprioceptive feedback reduces the fall.

Charles Sherrington is credited with coining the term proprioception, which he later described as the sense of joint and body mobility as well as the position of the body, or body segments in space and perceptions of the relative flexions and extensions of our limbs. According to Sherrington, the sense of movement and bodily position is known as proprioception, Perception, which comes from the Latin percepio (perceive), is the process of identifying, organizing, and interpreting sensory input. For instance, individuals to internally represent and comprehend their reality. [10]

An ankle joint contains a high density of proprioception located in the ligaments, tendons, muscles surrounding the joint. These provide information about positions of movement of ankle to central nervous system. It allows the body to detect changes in ankle position and prevent excessive movement that could lead to injuries. Deficit in the ankle can significantly increase the risk of injuries. Better proprioceptive awareness can lead to more precise movement. [11]

Foot sensation and lower leg proprioceptive inputs are two important components of standing balance. Lower leg proprioception leads to reflexes in ankle muscles that help in the activation of other automatic postural responses to the desired postural strategy. Reduced lower limb proprioception affects the accuracy and efficiency of balance responses, such as ankle and step strategies, and leads to poor balance in diabetic individuals. Diabetic individuals with neuropathy are more likely to maintain their balance utilizing hip strategies, which rely heavily on vestibular input; consequently, the inclusion of ankle techniques is required for balance improvement. [12]

The findings of the study conducted by Saleh et al. On the impact of ankle proprioceptive exercises for improving diabetic peripheral neuropathy patients' gait provide information to support the beneficial effects of ankle proprioceptive training in enhancing diabetic peripheral neuropathy patients gait ability. [13]

Somatosensation – body senses – consists of a proprioceptive feeling of body position via spindles of muscles and joint receptors, as well as a tactile sense via cutaneous receptors in the skin. [14] Tactile stimuli that activate fast- conducting sensory and proprioceptive fibers. [15]

Tactile cues or tactile prompts involve the use of physical touch or an object to provide feedback or to stimulate a joint or muscle. The tactile cue improving motor control allows a patient to recognize the correct muscle activation patterns needed to perform an exercise or activity properly. It enhances body consciousness, can lead to better movement control and posture, and can help to reduce pain or discomfort. Help the patients to facilitate the correct muscles, which additionally leads to the correct muscle memory of the exercise or activity. Enhancing proprioception by touch cues where their body is in space and how they are moving, which can help with balance and drop the probability of falling. [16]

The Toronto Clinical Neuropathy Scale (TCNS), which measures symptoms and sensory-motor signs, was utilized as a clinical tool for assessing neuropathy severity. A TCNS score range of zero to nineteen [17]. A reliable and valid scale for identifying and staging diabetic sensorimotor polyneuropathy is the Toronto Clinical Neuropathy Score [18].

Functional mobility is evaluated using the time up and go test. Where weight and height measurements are regularly taken during the procedure, patient sat in s sturdy armchair with a backrest. Stick a tape three meters in front of the chair's edge on the floor. Patients were instructed to walk at a normal pace rather than a fast one. While sitting on the chair, the back of their spine is against the backrest of the chair, and their hands rest on the armrests. Patients had to get out of the chair, walk three meters, turn around and then return to the chair to sit down.[19]

Need of the study

Proper evidence behind ankle proprioception training and additional tactile cues for lower extremities to improve balance in diabetic neuropathy patients is sparse. Poor balance and increase risk of fall is major complaint of diabetic peripheral neuropathy patients. Proprioceptive training improves balance, and proprioceptive feedback reduces the fall. Tactile cues enhance body consciousness, can lead to better movement control and posture, and can help to reduce the risk of fall and improve the proprioception.

Aim and objective of the study

Aim of the study

- The aim of the study is to find out the effectiveness of tactile cues with ankle proprioceptive training on improving the balance among diabetic peripheral neuropathy clients

Objective of the study

- To determine the effects of tactile cues in improving the touch sensation for DPN subjects
- To find out the influence of ankle proprioception exercise in improving the sensorimotor performance for DPN subjects
- To evaluate the effectiveness of utilizing tactile cues in conjunction with ankle proprioceptive training to enhance balance in individuals diagnosed with diabetic peripheral neuropathy (DPN).

Hypothesis

Alternate hypothesis : there will be a significant difference between Group A (ankle proprioceptive exercise with tactile cues) and Group B (Proprioceptive exercise)

Null hypothesis : there will be no significant difference between Group A (ankle proprioceptive exercise with tactile cues) and Group B (Proprioceptive exercise)

Review of literature

1. Diabetes mellitus

World Health Organization (2021) Diabetes is a dangerous disorder characterized by either insufficient insulin generation by the pancreas or ineffective insulin utilization by the body. A hormone called insulin controls blood glucose levels. Hyperglycaemia, also known as raised blood glucose or blood sugar, is a typical consequence of uncontrolled diabetes, which leads to noteworthy damage to the body's systems, most notably arteries and nerves. [20]

2. Diabetic peripheral neuropathy

Zhu J, Peng (2024) et.al DPN is a broad potential clinical pathology of peripheral nervous system. Patients with peripheral nervous system have numbness, tingling, weakness of limb, burning sensation. Patients have increased risk of falling due to insensate foot. It's occurred both T1DM and T2DM but more common in T2DM due to comorbidities. Hyperglycaemia causes metabolic abnormalities and oxidative stress. It disturbs the functions of Schwann cells and leads to nerve damage. These make the sensory neurons vulnerable. These are the causes of diabetic peripheral neuropathy. Diabetic peripheral neuropathy is a stocking and glove distribution. It’s characterized by damage to both myelinated and unmyelinated nerves. Its leads to impaired nerve conduction velocity and abnormal sensation. [21]

3.Burden of the disease:

By 2024, projections from the international diabetes federation (IDF) indicate that one in eight adults about 783 million people, will be living with diabetes, it shows 46% increase diabetes mellitus. Recently 537 million adults aged group between 20 to 79, or 1 in 10, have diabetes, with this number anticipated to rise to 643 million by 2030 and 783 million by 2045. In middle income countries, and 4.0% in low-income countries. The prevalence of impaired glucose in fasting was higher than the diabetes, particularly affecting those aged group

between 50-69, followed by individuals aged between 30-49and 18-29, the most productive years of life. The World Health Organization and IDF identifies that in developing countries, the 35-64 age group had the highest prevalence of diabetes, compared to the 65+age group in developed countries. [22]

4.**Sanjay Kumar Gupta (2010) et.al.** he ICMR-INDIAB study indicates that diabetes is more prevalent in urban areas compared to rural ones, with the highest rates in the 55-64 age group (Urban: nearly 25%, Rural: nearly 10%). In 1990, India's total disability-adjusted life years were composed of 61% from communicable, maternal, neonatal, and Nutrional diseases (CMNNDs), 30% and 9% from non-communicable disease and illness. [23]

5. **Rajendra Pradeepa and Viswanathan's (2021) et.al Epidemiology of Type 2 Diabetes in India explores this complex terrain.** T2DM, which is a complex disease with a surprising rate of growth and an array of underlying causes in India. In addition to showing that diabetes prevalence is higher in urban areas, the authors' thorough analysis of diabetes demographic distribution also shows that diabetes prevalence is rising in rural areas as a result of changing lifestyles. They point out that sedentary behaviour, obesity, higher calorie intake, and genetic susceptibility all significantly contribute to this trend. They highlight the impact type 2 diabetes has on the Indian economy, emphasizing the financial strain it places on both the nation's healthcare system and the pockets of those who are affected. The author concludes by emphasizing the need for government agencies, healthcare providers, and community organizations to work together to coordinate efforts to address type 2 diabetes in India. The nation can lessen the negative consequences of this chronic illness and enhance the lives of millions of those who are impacted by it by putting into practice efficient prevention and management measures.[24]

6.**Maraaa, Ozkan (2021) et.al address ankle proprioception in patients with T2DM**. the study found that patients with T2DM often experience impaired ankle proprioception, which can lead to balance issues and an increased risk of falls. consequently, the authors recommend incorporating proprioceptive training and balance exercises into the management and treatment plans for patients with t2dm to mitigate these risks and improve their quality of life. [25]

7.**Veeramani (2023) et.al investigates the comparative effects of proprioception exercise versus a focused regimen of exercises on balance and quality of life in individuals with DPN.** The findings indicate significant improvements in balance and quality of life for participants in both exercise groups underscore the importance of exercise in managing diabetic neuropathy symptoms. The nuanced differences in improvement between two groups with the proprioception exercise group showing greater gains in balance and the focused regimen group excelling in functional aspects, provide valuable insights into the tailored management of this condition. This study concludes that proprioception exercise is better and improves balance and quality of life for DPN patients. [26]

8.**Shankar.V Pradhap (2023) et.al Investigates the effect of proprioceptive exercises, and compared to targeted treatment program for balance.** This study results suggest that both types of exercises had positive effects, with proprioceptive exercises significantly improving balance and quality of life in these patients. It could be beneficial for DPN Patients. [27]

9.**Pavana (2021) et.al investigates an effectiveness of core stability exercises and proprioception exercises on the balance in subjects with the DPN**. This study concludes that both core stability exercises and proprioception exercises are effective in improving the balance in an individual with the DPN. This is an exercise can be beneficially integrated into rehabilitation programs to reduce the risk of falls in diabetic peripheral neuropathy patients. [28]

10.**Mahdieh, Mehri, Abbas (2021) et.al Discuss the crucial role of ankle reflexes which are influenced by proprioception in lower limb, in maintaining balance and initiating automatic postural adjustments necessary for stability**. They argue that any impairment in lower limb proprioception can significantly diminish the effectiveness of balance responses, leading to compromised postural control. Consequently, they emphasize that proprioceptive training is essential as it enhances both balance and the proprioceptive sense in the lower limb, thereby improving overall postural stability and response. [29]

11.**The study by Espejo–Ángeles (2020) et.al. Investigates the impact of proprioceptive exercises on the balance and physical capabilities of elderly individuals living in institutional settings**. As people age proprioception acuity declines leading to poorer balance and higher risk of falls. In this study participants were randomly assigned to either an intervention group, which received proprioception exercise program or control group which did not receive any specific intervention. The findings of this study highlight the potential benefits of proprioceptive exercise for improving balance and mobility in older adults.[30]

12.**Irshad Ahmad (2019) et.al investigates an impact of sensorimotor exercise on balance measures and proprioception among middle aged and older persons with DPN.** This study included middle aged and older adults diagnosed with the DPN, age ranging from 40 to 65 years old. Participants underwent sensory motor the training program designed to enhance proprioceptive feedback and the balance. This conclusion of the study suggests that the sensorimotor training has a positive effect on the balance measures and the proprioception among middle - aged and older adults with DPN, it improved stability and awareness of body position. [31]

13.**Saleh, Marwa (2019) et.al investigating impact of ankle proprioception exercise on gait and risk of falling in DPN patients.** This study addresses the issue by implementing the targeted training protocols to enhance proprioceptive feedback specifically at the ankle joint. Ankle proprioception a pivotal aspect of sensorimotor control, refer to body innate capacity to perceive and interpret the position and movement through specialized receptor housing within the ankle joint. The conclusion of the study revealed that ankle proprioception training improves the gait parameters and reduces the fall. [32]

14.**Kamatchi (2018) et al. investigated the impact of proprioception exercise and backward walking on DPN Patients.** In this study, participants are divided into two groups. One group received proprioception training, and the other group received backward walking training for about 12 weeks. The conclusion of the study suggest that both trainings are improving the proprioception awareness of lower limb, reducing the risk of falling, and improving functional balance in DPN Patients. [33]

15.**Abeer El wishly and Enas (2012) et.al argue that Proprioceptive training increases the triggering of proprioceptive signals from skin receptors in the feet**. These receptors respond to touch & pressure and provide important information to maintaining balance. It stimulates muscles mechanoreceptors during muscles contraction. It will increase proprioceptive feedback helps to improve the balance and the quality of life in DPN Patients. [34]

16.**James K. Richardson (2001) et. al argued that focused regimen aimed at increasing ankle strength can significantly improve balance in older adults with mild to moderate peripheral neuropathy.** Targeting an ankle muscle in exercise program, strength the muscles and reducing the risk of falls. These findings revealed that improving an ankle strength through specific exercise can be an effective strategy for an enhancing balance and the stability in this vulnerable population. [35]

17.**Ayman Mohamed (2020) et.al investigating the benefits of including proprioceptive exercise to balance training among older persons with the diabetes**. This review findings an indicate that the incorporating proprioceptive exercises enhances overall balance and the stability, reduces the risk of falls and improves functional mobility among older adults with the diabetes. Enhanced sensory feedback and the muscles coordination from proprioceptive training contribute to better postural control, which is particularly beneficial for individuals with the diabetic complications affecting their balance. Thus, the study supports the

inclusion of proprioception exercise in balance training regimen for older diabetic adults to enhance their quality of life and reduce the likelihood injuries from falls. [36]

18.**Ghazavi N, Sadat (2021) et .al they discuss the effect of proprioceptive exercises on lower extremity proprioception in patients with diabetic neuropathy**. The researchers conducted the randomized clinic trail, they include DN patients aged between 18 to 65 years old. Proprioception exercises are given to the patients. Intensity of the exercise was adjusted based on patients' ability. Findings of the study suggest that proprioceptive exercise could improve proprioception of patients with DPN. It promotes muscle control and increases the function of the nervous and muscular system.[37]

19.**Claudio Henrique Meria(2023) et.al investigated plantar tactile sensitivity in elderly women after traditional proprioceptive exercise and exergame.** They investigate an impact of two different types of training on the foot sensitivity of elderly women. Study compares conventional proprioceptive training, which is typically involves exercise designed to improve the balance and body awareness with exergame which are video games that combine exercise with interactive gameplay. The study found that both conventional proprioceptive training and exergames effectively improved plantar tactile sensitivity in elderly women. Proprioceptive exercise group showed significant improvement in balance and foot sensitivity.[38]

20.**Udayashankar, D &Premraj (2017) et.al investigates the effectiveness of the TCNS in diagnosis DPN**. This study assesses an applicability of Toronto clinical neuropathy score as a diagnostic tool and its correlation with the severity of DPN to the patients with diabetes. The researchers found that the TCNS is a valuable and reliable method for diagnosing and grading the severity of neuropathy to the diabetic patients. The TCNS can be effectively utilized in clinical settings to identify patients at the risk and to facilitate timely and appropriate management of DPN. [39]

21.**Bril, Vera (2002) et.al they discuss the validation of TCNS for DPN.** TCNS was developed as a clinical tool to systematically assess the presence and severity of this condition. The study determines the reliability and accuracy of the TCNS by comparing TCNS scores with other diagnostic methods. The researcher demonstrates that the TCNS is a valid and effective scoring system for clinical use providing a standardized approach to evaluating diabetic patients for neuropathy. This validation supports both clinical practice and research settings to improve the diagnosis and management of diabetic polyneuropathy. [40]

Materials and methodology

STUDY DESIGN:

- Pre – experimental test
- Post – experimental test

STUDY TYPE:

- Comparative type

Study method:

- Comparison study – randomized control- trail

STUDY SETTINGS:

- Community setting

Sampling technique:

- Purposive sampling

SAMPLE SIZE:

- Total number of samples is 50

Group A – 25 Samples (ankle proprioceptive exercise and tactile cues)

Group B – 25 Samples (ankle proprioceptive exercise)

STUDY DURATION:

- 12 weeks

INCLUSION CRITERIA:

- Type 2 diabetes peripheral neuropathy subjects
- Both male& female
- Age 40 to 65years,
- Previously diagnosed by physician
- Patients under medications
- Subject with diabetic peripheral neuropathy greater than ten year
- Toronto clinical neuropathy score 9-12+ severe
- Time up and go test 15-20 seconds

Exclusion criteria:

- Subject unable to provide proper medical details
- Diabetic ulcers/Scars in the feet
- Other neurological \ orthopaedic impairment
- Vestibular impairment
- Patient with crutches or walking aids
- Severe retinopathy.

MATERIALS TO BE USED

- Knee hammer
- Weight machine
- Sensory mat
- Chair with armrest

PROCEDURE:

The purpose of the study was explained to the patients, and they signed a prior informed consent form. The experimental study was conducted on 50 participants diagnosed with diabetic peripheral neuropathy. They were selected using a simple random sampling method. Patients were selected based on the inclusion criteria. A detailed history was taken, and a general physiotherapy examination was carried out for patients. Toronto clinical neuropathy scale was used in pre- intervention screening to assess the severity of diabetic peripheral neuropathy. It's mainly assessed the sensorimotor functions and Timed up and go test, used to assess the balance and functional mobility of patient and also indicates the risk of fall. participants were assigned into two groups, Group A (the experimental group), Group B (the control group). The experimental group received tactile cues with ankle proprioception training, and control group received only ankle proprioception training for three days a week up to forty-five minutes for twelve weeks.

Group A

It starts with ten minutes of warm up activity. Followed by ankle proprioceptive exercise and tactile cues

Proprioceptive training

1.WEIGHT SHIFTING EACH DIRECTION

- **Front to back weight shifting**

- Stand feet hip-width apart.
- Move your weight forward onto your toes, lifting your heels slightly off the ground.
- Hold for fifteen seconds, then move your weight back to your heels, lifting your toes slightly off the ground
- Repeat for five repetitions

.

- **Side to side weight shifting**

- Stand with your feet wider than hip-width apart.
- Shift your weight to the left, bending your left knee slightly while keeping your right leg straight.
- Hold for fifteen sec, then shift your weight to the right, bending your right knee slightly while keeping your left leg straight.
- Repeat it for five times.

- **Diagonal weight shifting**

- Stand with your feet hip-width apart.
- Shift your weight diagonally forward to the left, stepping your left foot slightly forward and to the left.
- Hold for fifteen sec then return to the starting position.
- Shift your weight diagonally forward to the right, stepping you right foot slightly forward and to the right.
- Repeat it for five times in each direction

2.One leg stance

- Stand straight and keep your feet hip width apart. hold a chair or wall if support is needed.
- Then lift your one foot off the ground and bend the knee slightly. keep other foot straight but not locked.
- Do these on both legs. hold this position for 15 seconds and repeat it for 5 times each leg.

3. Tandem stance

- To balance stand straight and position one foot in front of the other.
- The heel of the front foot should touch the toes of the back foot.
- Maintain a straight line and balance yourself.
- Hold this position for fifteen seconds.
- Repeat this five times for each leg.

4. Heel toe walking

- Stand with your feet together, following the floor lines.
- Step forward with right foot and place your heel precisely in front of your left foot.
- Shift all the weights to your right foot, Continue walking.
- Step forward with your left foot, heel directly in front of the toes of your foot.
- Moving forward in this heel – toe pattern for fifteen seconds.
- Repeat the exercise for five times.

5.SQUATS

- Stand straight with your feet shoulder – width apart, toes pointing slightly outward.
- Extend arms straight front for your support to maintain the balance.
- Try to lower your body until your thighs are level with the ground.
- Make sure that your knees do not go past your toes and your weight is on your heels.
- During rising up from squat position, push your heels to stand back up to the starting position.
- Repeat this for ten counts and five times.

Tactile cues

1.SPOT MARCING

- Marching in place, lifting your knees high, and alternating legs.
- Perform one to two minutes on each leg with three sets
- This exercise improves the proprioception and balance. The uneven surface of the sensory mat challenges the muscles and joints to adapt, improving coordination and strength in the lower body.

2.Sensory walk

- Walk across the sensor mat slowly and carefully to the different textures and surface of the mat.
- Walk across the sensory mat for 10 steps and 3 sets.
- this exercise stimulates the sensory receptors present in the feet, improve the tactile feedback and enhance the sensory -motor integration. It helps to better balance, coordination and proprioception of foot.

3. WALKING OVER THE HEEL

- walking with placing the heel down on sensory mat.
- Walk 10 feet distance with 3 sets
- This is an exercise promotes proper gait mechanics and strengthens the muscles involved in the heel to toe walking. It's improved the balance and the stability by controlled movements of the foot and weight distribution.

4. TANDEM WALKING

- To balance stand straight and position one foot in front of the other.
- The heel of the front foot should touch the toes of the back foot.
- Maintain a straight line and balance yourself.
- Hold this position for fifteen seconds.
- Repeat this five times for each leg.

GROUP B:

Received only proprioceptive training.

- Weight shifting each direction
- One leg stance
- Tandem stance
- Heel toe walking
- Squats

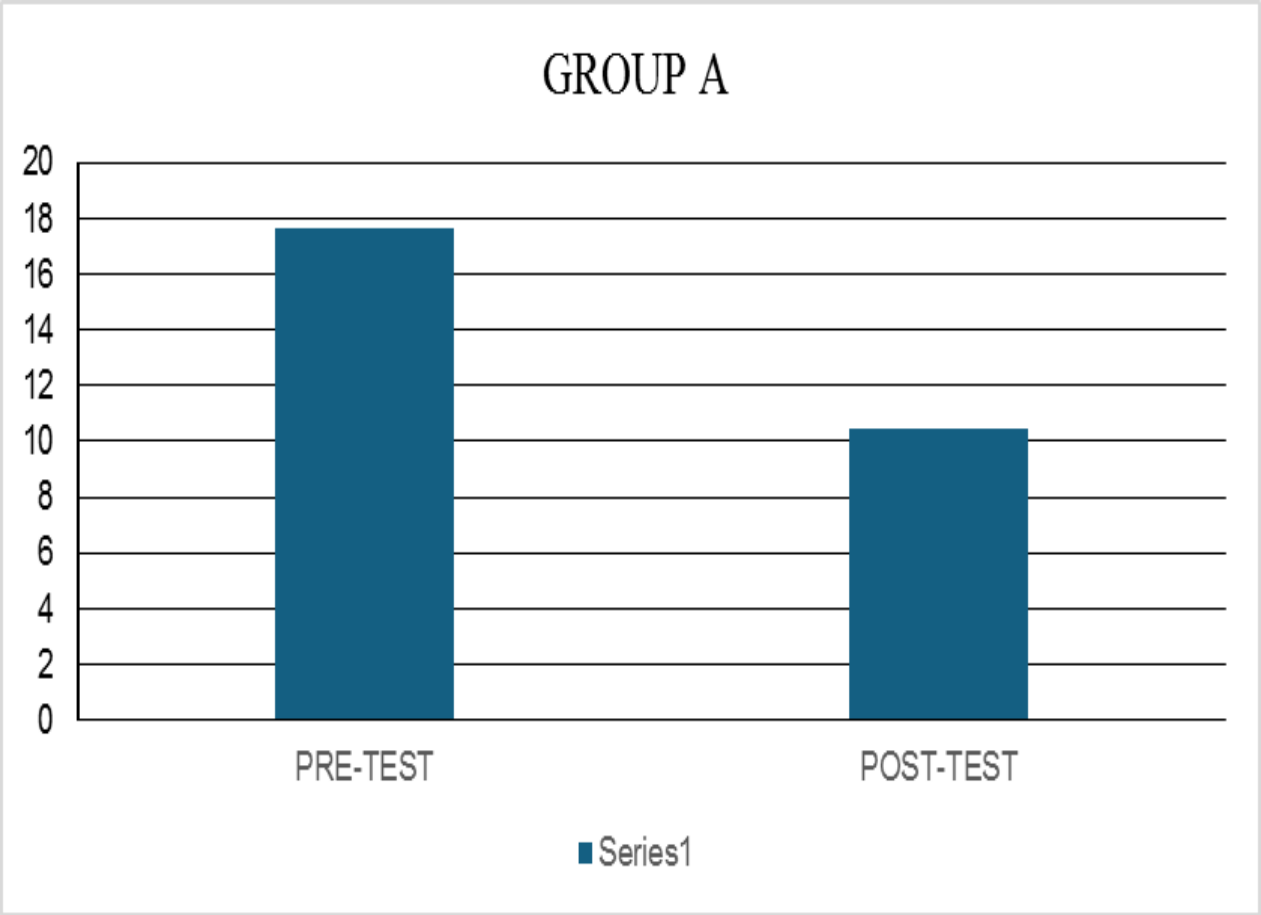
Outcome measures

Toronto clinical neuropathy score, it's used to assess the severity of diabetic peripheral neuropathy. It's mainly assessed the sensorimotor functions.

Time up and go test, it's used to assess the balance, functional mobility of patient and also indicates the risk of fall.

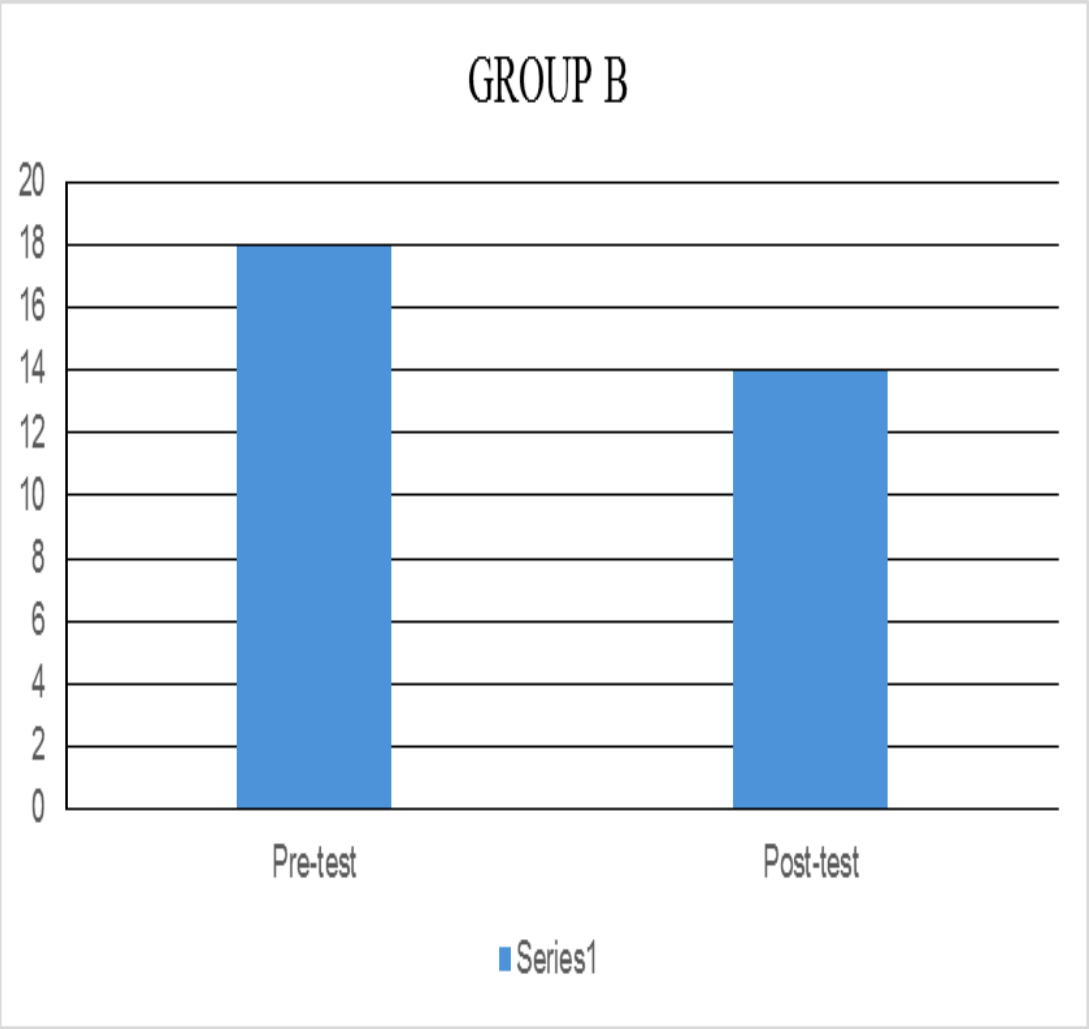
Toronto clinical neuropathy score is used to evaluate the changes in diabetic peripheral neuropathy sensorimotor functions. This scale contains symptoms scores, sensory test scores and reflex scores. The score range being 0 to 19. Severity of neuropathy classified into mild, moderate and severe. No neuropathy scores 0 to 5, mild neuropathy scores 6 to 8, moderate neuropathy scores 9 to 11 and severity of diabetic neuropathy score 12 to 19. timed up and go test measure the risk of fall and progress of balance. Patients start in a seated position, stand-up, walk three meters, turn around, return to the chair, and sit in it. Time stopped after the patient seated. A score of ten seconds or less is considered normal, under twenty seconds indicates acceptable mobility, and less below 30 seconds indicates a mobility concern.

Graphical representation:



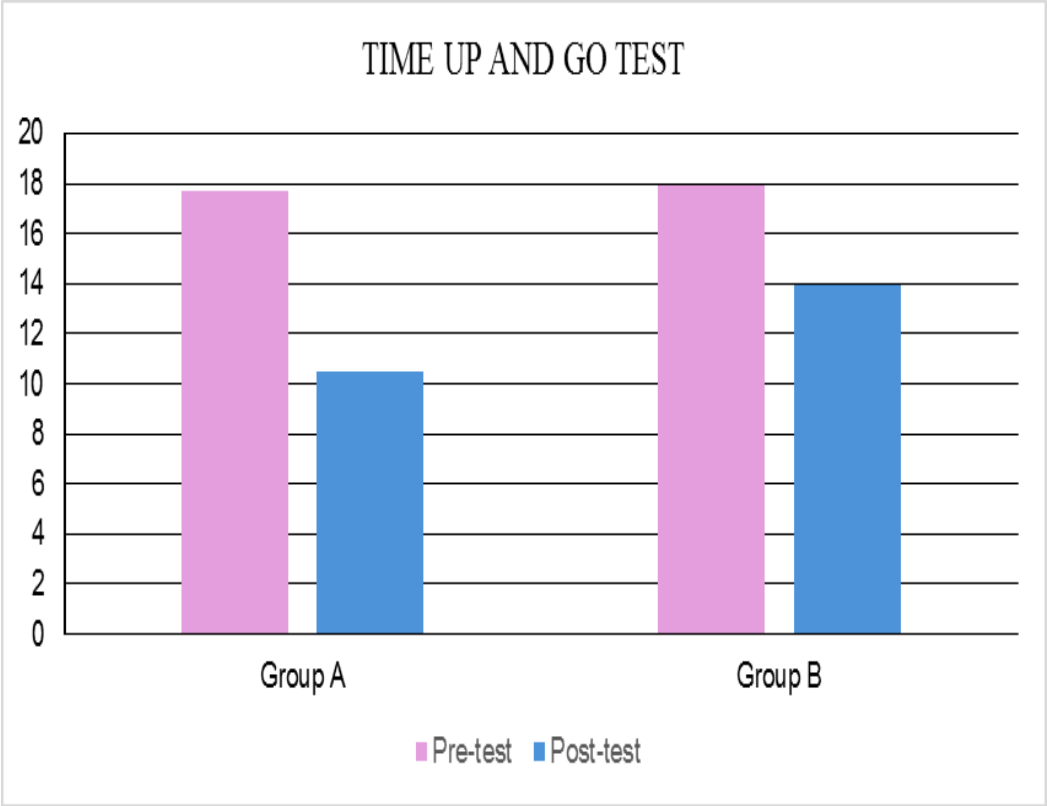
Graph – 1

(Within the group analysis of Group A for TUG)



Graph – 2

(Within the group analysis of Group B for TUG)



Graph - 3

(Between the group analysis of the pretest and post-test values of Group –A and Group- B for TUG)

Results

Descriptive statistics for demographic variables of both Group A and Group B .

Mean age of Group A is 47.72 and standard deviation is 7.961, mean age of Group B is 48.48 and standard deviation is 5. 994. Mean height of Group- A is 157.80 and standard deviation is 6.658, mean height of Group B is 158.92 and standard deviation is 7.884. Mean weight of Group A is 65.84 and standard deviation is 6.712, mean weight of Group B is 68.24 and standard deviation is 7.395. Mean duration of diabetes in Group A is 10.36 and standard deviation is 3.067, mean duration of diabetes in Group B is 10.76 and standard deviation is 2. 847. All these four parameters are not statistically significant. This shows equal distribution to both groups.

Intergroup comparison;

TCNS score Post test value of group A is 6.68 ± 0.802 and group B is 9.04 ±1.241 .

TUG test Post test value of Group A is 10.48 ± 1.159 and group B is 13.96 ±1.989.

Group A had better reduction in TCNS scores (3.68) than Group B (1.44), this was found to be statistically significant similarly Group A had better reduction in TUG test (7.20) than Group B TUG test (3.96) and this was also found to be statistically significant

Intragroup comparison;

Group A shows significant improvements in both TCNS and TUG test scores. Average mean reduction in TCNS score is 3.68 points and decrease in TUG time by 7.20. These indicates the improvements in both diabetic peripheral neuropathy symptoms and functional mobility and reducing the risk of fall. Group B, also shows significant improvements but the mean reduction in TCNS is 1.44 and TUG test is 3.96, these indicates the moderate reduction and less improvements compared to Group A.

Both group A and group B, the P values for TCNS and TUG test times are 0.000, this value indicates highly statistically significant result. These shows both group shows improvement in interventions but the magnitude of the improvements in neuropathy symptoms and functional mobility was greater in GROUP A (ankle proprioceptive training along with tactile cues) compared to GROUP B (ankle proprioceptive training alone)

Discussion

The study aimed to investigate the effectiveness of ankle proprioceptive training combined with tactile cues in diabetic peripheral neuropathy patients. Our findings suggest that the ankle proprioception training along with tactile cues, shows improvements in proprioceptive acuity, balance and stability. The effectiveness of these exercises was measured using Toronto clinical neuropathy score and timed up and go test. Before intervention, baseline demographical data (name, age height weight and duration of diabetes) are collected. Both Groups A and B, age, height, weight, and duration of diabetes are equally distributed. Pre and post- test data were collected from both groups and analyzed to compare the effectiveness of intervention. The result indicates that both groups showed improvement in TCNS and TUG scores, it shows enhanced neuropathic symptoms and functional mobility.

Group A shows significant improvement in TCNS score and TUG test timing compared to pretest values. Additional tactile cues enhance the touch sensation an improve the stability, coordination during the dynamic balance task, its leads to reduction of TUG times and improve the TCNS scores. Group B also exhibit improvements in TCNS score and TUG test but less changes compared to Group A. Proprioceptive exercise alone enhances the sensation but lack of tactile cues may limit the extend of improvement.
The previous study conducted by Kamatchi et.al (2018) investigated the impact of proprioception exercise and backward walking on DPN Patients for12 weeks. The study shows that both trainings are enhancing the proprioception awareness of lower limb, reducing the risk of falling, and improving functional balance in DPN Patients.

Similar study conducted by Veeramani et.al (2023) compare the effects of proprioception exercise versus a focused regimen of exercises on balance and quality of life in individuals with DPN. The findings indicate significant improvements in balance and quality of life for participants in both exercise groups underscore the importance of exercise in managing diabetic neuropathy symptoms. This study shows that proprioception exercise is better and improves balance and quality of life for DPN patients

The effects of proprioception training were markedly enhanced by additional tactile cues. Different textured mats were used to give tactile cues. It gives the DPN patient more sensory input. Patients respond more actively and stick to their workout regimens when tactile signals are used through varying textures. By enhancing proprioception, it lowers the chance of falling. Thus, improving balance through a combination of proprioceptive and tactile training can help to lower the risk of fall-related injuries and promote a safer daily routine.

Conclusion

The study findings suggest that ankle proprioceptive training combined with additional tactile cues produces considerable improvements in the balance in DPN patients compared to proprioceptive training alone. This combined training lowers the chance of falling, and increases quality of life and functional mobility.

Limitations and recommendation

- A high sample size is necessary to enable the results to be more broadly applied and the intervention more relevant.
- Few more outcome measures can thus be included in future research to increase the sensitivity.
- Subsequent investigations ought to track their blood glucose levels.
- Various of sensory signals can be used to focus on other sensory functions in DPN.

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