EFFECTIVENESS OF LOWER EXTREMITY WEIGHT BEARING TRAINING ALONG WITH THE CONVENTIONAL TRAINING TO IMPROVE BALANCE, VIBRATION PERCEPTION AND ANKLE MOBILITY IN DIABETIC PERIPHERAL NEUROPATHY PATIENTS

-A QUASI EXPERIMENTAL STUDY

Dissertation submitted to The Tamil Nadu Dr. M.G.R. Medical University towards partial fulfillment of the requirements of **MASTER OF PHYSIOTHERAPY (Advanced PT in Neurology)** degree programme.

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CERTIFICATE

This is to certify that research work entitled **"EFFECTIVENESS OF LOWER EXTREMITY WEIGHT BEARING TRAINING ALONG WITH THE CONVENTIONAL TRAINING TO IMPROVE BALANCE, VIBRATION PERCEPTION AND ANKLE MOBILITY IN DIABETIC PERIPHERAL NEUROPATHY PATIENTS" - A QUASI EXPERIMENTAL STUDY** was carried out by the candidate bearing the **Register No: 271520081**, KMCH College of Physiotherapy towards partial fulfillment of the requirements of the **Master of Physiotherapy (Advanced PT in Neurology)** of The Tamil Nadu Dr. M.G.R. Medical University, Chennai - 32.

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ABSTRACT

BACKGROUND: Diabetic peripheral neuropathy (DPN) is a condition which challenging the quality of life of the patients. According to the world health organization report, 108 million persons had diabetes during 1980s; 422 million persons had diabetes in the year 2014. The global prevalence of diabetes has nearly doubled since 1980, rising from 4.7% to 8.5% in the adult population. Mostly the diabetic patients are sedentary in their life style, inactivity contribute the de-conditioning of the skin, uncontrolled hyperglycemia and lowering the tolerance for weight bearing activities. Historically these patients are advised to avoid more stress to the plantar tissues to avoid foot ulceration, but moderate lower extremity weight bearing exercises help to improve the patient mobility without increase the risk of foot ulcers. A progressive program may preserve the lower extremity muscles, improve sensory perception and functional balance.

AIM&OBJECTIVE: To study the effect of lower extremity weight bearing training along with conventional training on static balance using sharpen Romberg test, on dynamic balance using TUG test, on vibration perception using biothesiometer and active range of motion using universal goniometer among Diabetic peripheral neuropathy patients.

METHODOLOGY: Quasi-experimental research design with purposive sampling technique was employed. 300 Type 2 diabetic patients were selected. Patients who have diabetic history more than 10years, age between 40-65 years, MNSI score >2 and vibratory perception between 15-50V were included. Thirty patients fulfilled the inclusion criteria and they were randomly allocated in to two group. Group A (experimental) received Lower extremity weight bearing training along with conventional training and group B (control) received the same conventional training alone. Post-test measures of thirty patients were taken after 8 weeks of treatment.

OUTCOME MEASURES: Static balance using sharpen Romberg test, dynamic balance using TUG test, Vibratory perception using biothesiometer and Active range of motion using Universal goniometer are used.

RESULTS: The data was analyzed using 't' test at 5% level of significance. The homogeneity is maintained between two groups. The experimental group that receive Lower extremity weight bearing training along with conventional training had significant improvement in both static balance (t stat=26.89), dynamic balance (t stat=27.8), vibration perception in right foot (t stat=12.07), left foot (t stat=16.74) and active ankle range of motion than the control group that receive only conventional training.

CONCLUSION: The results of this study conclude that lower extremity weight bearing training enhance balance both static and dynamic, vibration perception and active ankle range of motion among diabetic peripheral neuropathy patients.

KEYWORDS: Diabetic peripheral neuropathy, Vibration perception, Biothesiometer, Balance, sharpen Romberg test, TUG test, Michigan neuropathy screening instrument,

1. INTRODUCTION

Diabetes mellitus is a metabolic disorder characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both. The effects of diabetes mellitus include long–term damage, dysfunction and failure of various organs[49]. Diabetes mellitus may present with characteristic symptoms such as thirst, polyuria, blurring of vision, and weight loss [WHO].

Diabetes mellitus is one of the most chronic health problem in world wide. According to the world health organization report, 108 million persons had diabetes during 1980s; 422 million persons had diabetes in the year 2014. The global prevalence of diabetes has nearly doubled since 1980, rising from 4.7% to 8.5% in the adult population. WHO report reveals that India has the largest number of diabetic patients. There is a raising trend in the prevalence of diabetes in India over recent years; the number of diabetic people in India is expected to increase from 32.7 million in the year 2000 to almost 69.9 million by 2025[10].

Diabetes mellitus is classified into

- Type 1diabetes mellitus [insulin-dependent; IDDM] occurs due to autoimmune beta-cell destruction, leading to absolute insulin deficiency.
- Type 2 diabetes [non-insulin dependent; NIDDM] occurs due to a progressive loss of beta-cell insulin secretion frequently on the background of insulin resistance.
- Gestational diabetes mellitus [GDM] diabetes diagnosed in the second or third trimester of pregnancy.
- Specific types of diabetes due to other causes e.g., monogenic diabetes syndrome, diseases of the exocrine pancreas, drug or chemical-induced diabetes[31].

Diabetic neuropathy is one of the late complications of diabetes mellitus, both Type1 & Type2. It has been defined as a symmetrical, length-dependent sensorimotor polyneuropathy due to metabolic and micro vessel alterations as a result of chronic hyperglycemia[6].50-60% of diabetic patients are estimated to having diabetic neuropathy.

The main risk factors are Poor glycemic control, advanced age, hypertension, long duration of disease, hyperlipidaemia, smoking, obesity, physical inactivity, heavy alcohol intake and exposure to neurotoxic agents such as ethanol[29].

Diabetic neuropathy is classified into

- Peripheral neuropathy [sensory, motor, sensory motor]
- Focal and multifocal neuropathies
- Autonomic neuropathy [CVS, GI].

One of the most common forms of neuropathic syndrome which occurs in both IDDM and NIDDM is diabetic peripheral neuropathy. It affects approximately 25% of people who had the diabetes for the past10 years and 50% of those who had the diabetes for the past 20 years, characterized by distal, symmetrical, sensory alterations that begin in the feet and ascend in to the legs and hands [typical glove and stocking pattern of distribution] with diminished ankle reflex[39].

Important pathophysiological mechanisms leading to the development of diabetic neuropathy are polyol pathway, advanced glycation and oxidative stress.

- **Polyol pathway: -** Hyperglycemia causes increased level of intracellular glucose in nerves leading saturation of normal glycolytic pathway. Extra glucose shunted to polyol pathway and converted to sorbitol dehydrogenase. Accumulation of sorbitol and fructose lead to reduced myoinositol, decreased membrane Na+/K+ - ATPase activity, impaired axonal transport and structural breakdown of nerves resulting abnormal action potential propagation

- **Advanced Glycation End Products (AGE):-** Excess glucose in hyperglycemia can lead to non-enzymatic glycation of proteins, nucleotides and lipids resulting in production of advanced glycation end products (AGE), affect the surrounding tissues causing thickening of collagen and endothelium. These products act on specific receptors including monocytes and endothelial cells to increase the production of cytokines and adhesion molecules which have a role in disrupting neuronal integrity and repair mechanisms.
- **Oxidative stress:-**The increased production of free radicals in diabetes may be detrimental via several mechanisms. They may directly damage small blood vessels supplying nerves leading to nerve ischemia.

The AGE products cause irreversible changes to myelin protein which results segmental demyelination of the peripheral nerves and damage to the neuronal microvascular function leading to impaired nerve perfusion[49].

The clinical manifestations of the diabetic peripheral neuropathy are divided into positive and negative symptoms. Positive symptoms include burning pain, altered and uncomfortable temperature perception, paraesthesia, shooting, stabbing pain, hyperaesthesia and allodynia. Negative symptoms include numbness, impaired or loss of sensory modalities i.e., touch, pressure, vibration, proprioception or joint position sense. Vibration sense is the first one to diminish with falling nerve conduction than proprioception and tactile sense, reduced muscle strength, and reduced ankle mobility[4].

Balance is defined as the ability to maintain an upright posture. It is divided into two; static & dynamic balance. Static balance is the ability to hold a position. Dynamic balance is the ability to transition or move between positions. According to Shumway-Cook the components of postural control includes musculoskeletal, internal representations, adaptive mechanisms, anticipatory mechanisms, sensory strategies, individual sensory systems and neuromuscular synergies. Balance deficits especially during complex activities are found to be the strongest predictor for falls[48].

S. Dixit et al[2015] reported that the presence of Diabetic Peripheral Neuropathy (DPN) causing increased postural instability larger range of sway in the anterior-posterior as well as the medial-lateral directions and higher sway speed compared to age matched controls. In quiet standing with eyes open, individuals with DPN have been shown to have 66% more sway compared to healthy people of similar age. The greatest decrease in postural stability in individuals with DPN has been seen with eyes closed, showing a reliance on vision to compensate for sensory deficits. Decreased vibration sense and loss of pressure sensitivity have been shown to be associated with recurrent falls. Because of decreased proprioceptive feedback during walking; older adults with diabetes walk slower and have greater stride variability, increasing the risk of falls[40].

In diabetic peripheral neuropathy the sensation in the plantar surface of the feet is affected due to decreased plantar perfusion, ineffective postural control and damages in the receptors of joint position and perception of movement. Decreased

muscle power leads to disturbance in balance thus leads to increase the risk of cutaneous injuries, foot ulcerations and risk of fall related injuries[36].

Insensate feet, loss of pain, decreased cutaneous and proprioceptive sensation, decreased muscle strength and discomfort in lower extremities, loss or absence of protective sensations in the lower extremities, impaired postural control leading to balance problems, risk of foot ulcerations, and a reduction in the quality of life in diabetic peripheral neuropathy patients[8].

People with DPN have historically been advised to be cautious about increasing their activity level. Prior to 2009, the Standards of Medical Care in Diabetes position statement published by the American Diabetes Association (ADA) included the recommendation that "in the presence of severe peripheral neuropathy, it may be best to encourage non–weight bearing activities such as swimming, bicycling, or arm exercises" due to the increased risk of skin breakdown, infection, and Charcot joint destruction. LeMaster et al. examined the incidence of foot ulcers in individuals with DPN who were assigned to a walking exercise group compared to a control group. They concluded that assignment to the weight-bearing activity group did not increase the rate of foot ulcers[19].

L J. Tuttle et al [2011] reports a moderate-intensity exercise program that was successful in increasing some measures of muscle strength, physical function, and activity without causing injury in an individual with diabetic peripheral neuropathy[24]. L.Allet et al [2010] in this study concluded that specific gait and balance training programme including gait and balance exercises combined with function oriented strengthening can improve balance and increase both muscle strength and joint mobility of diabetic patients[21].

Weight bearing exercises in diabetic peripheral neuropathy is an interesting field for the researchers too as an emerging treating approach. But the question still remain whether the weight bearing training improves the regeneration of the peripheral nerve, is it effective to reduces the negative symptoms of diabetic peripheral neuropathy. This study intended to study the effect of lower extremity weight bearing exercise to improve balance, vibration perception and ankle mobility in diabetic peripheral neuropathy patients.

1.1 NEED FOR STUDY

Diabetic peripheral neuropathy is a condition which challenges the quality of life of diabetic patients. In severe or chronic cases they compromise in somatosensory input from periphery. The diabetic peripheral neuropathy patients have difficulty in maintaining balance, reduce speed of walking, impaired sensory perception, may have the foot ulcers, severe pain, reduced ankle mobility and muscle weakness etc. These issues decrease the overall quality of life of the patients.

Historically people with diabetic peripheral neuropathy have been advised to avoid weight bearing activities, but inactivity may contribute the deconditioning of the skin, uncontrolled hyperglycaemia and lowering tolerance for weight bearing activities. Now in recent studies they suggest weight bearing exercise programs are effective in diabetic peripheral neuropathy patients, which help to improve the patient mobility without increasing the risk of foot ulcers. Patient with insensate feet who participate in daily weight bearing activity decrease risk of foot ulceration compared with those who are less active. A progressive program may preserve the lower extremity muscles, make plantar tissue tolerant to stress, reduce ulceration and improve the glycemic control.

Vibration and passive tactile cues are useful to activate the sensory afferent system to improve balance in diabetic patients. Aerobic exercise is also effective in reducing the risk or severity of peripheral neuropathy in patients. A set of Group exercises are effective in improving balance in older people and reduces the risk of falling. Any changes in shear stress and pressure on the soles of the feet during standing tasks can stimulate mechanoreceptors to the higher nervous centres, which leads to increased balance ability in patients with diabetic neuropathy.

Hence this study is an attempt to see the effectiveness of lower extremity weight bearing training along with conventional physiotherapy to improve balance and vibration perception and ankle mobility in diabetic peripheral neuropathy patients.

2. REVIEW OF LITERATURE

2.1 DIABETIC PERIPHERAL NEUROPATHY

2.1.1 **Gul Shujat et al [2017][10]**

This review examines the prevalence of peripheral neuropathy; in 2012, 1.5 million deaths occur due to diabetes. Globally 422 million adult have diabetes in 2014, the global prevalence of diabetes nearly doubled since 1980.over the past decade diabetes prevalence rise faster in low-middle income countries than in high income countries. The international diabetes federation estimated that the total number of diabetic subjects to be around 40.6 million in India and they predict that this number will rise to 69.9 million by the year of 2025.

2.1.2 Aquil Ahamad et al [2016][6]

Neuropathy is one of the most troublesome complication affecting individuals with diabetes. The resultant loss of function in peripheral nerve causes loss of protective sensations and impairs patients' ability to protective incipient or even apparent ulcerations in the feet. Nerves of the lower limbs are more susceptible to diabetic assault as compared to upper limb suggesting that long nerves are commonly affected also apart from duration and severity of diabetes, smoking, it is an independent factor for diabetic neuropathy.

2.1.3 Nisar et al [2015][31]

Diabetes mellitus is associated with severe microvascular and macro vascular complications with major implications for public health. Diabetes neuropathy is a very problematic complication of diabetes mellitus. It is associated with severe morbidity, mortality and a huge economic burden. The presence of diabetic neuropathy was significantly associated with HbA1C level and the duration of diabetes.

2.1.4 S R Colberg, A I Vinik [2015][39]

Both peripheral and autonomic neuropathies are characterised by a progressive loss of nerve fibre function. Most peripheral neuropathy affects the

extremities particularly the lower legs and the feet, but also the hand. The patients can benefit from regular participation in mild to moderate aerobic , resistance and balance activities assuming they take any potential alterations into account to ensure that exercises is safe and effective.

2.1.5 S. Dixit et al [2016][40]

This study estimated that worldwide prevalence of diabetes in 1995 was 4.0% and rise to 5.4% by the year 2025. It is found that a person having impaired glucose tolerance (126-200 mg/dl) testing is 10 times at the risk of developing diabetes than the person with normoglycemia. Various studies conducted all over the world, have found an increase in the prevalence of Type 2 diabetes and have concluded that there is an increase in the incidence, prevalence, and mortality due to diabetes in the elderly population. In a survey done by the World Health Organization (WHO), it was estimated that there were 108 million diabetics in 1980, which is all set to increase to 300 million by 2025. Another estimate of the problem by Shaw *et al*., found that the highest regional prevalence was reported for North America (10.2%) followed by south Asia (6.7%).Studies on diabetes in various parts of India found high trends of prevalence of diabetes and its risk factors among Indian population, with an alarming increase in diabetes and its complications.. Complications of peripheral neuropathy include severe pain, loss of ambulation, and increased risk of foot ulceration and amputation.

2.1.6 Pinzur MS [2011][29]

Diabetic peripheral neuropathy affects 65% of individual with type1and type 2diabetes. The main two predictors for the development, progression and severity of diabetic peripheral neuropathy are duration of diabetes and metabolic control. Peripheral neuropathy is the most predictive risk factor for the diabetic foot ulcer, foot infection and Charcot foot arthropathy. Preventive strategies after diabetic peripheral neuropathy proved to decrease the risk of the development of diabetic foot ulcers, foot infection, Charcot foot or amputation.

2.2 IMPAIRMENTS IN DIABETIC PERIPHERAL NEUROPATHY

2.2.1 M.M Almurdhi et al [2016][30]

This study was to find out the changes in lower limb muscle strength and volume in patients with diabetes peripheral neuropathy. They did a study with 20 type 2 diabetes mellitus patients and 20 healthy subjects as control group were matched by age, sex, & BMI for quantify muscle strength and size in patients with type 2 diabetes mellitus in relation to the severity of diabetes intramuscular non contractile tissue [IMNCT] &vitamin D deficiency. They found that patients with type 2 diabetes mellitus have a significant reduction in proximal and distal leg muscle strength and a proximal but not distal reduction in muscle volume possibly due to greater intramuscular fat accumulation in distal muscles.

2.2.2 P Hewston, N Deshpande [2015][32]

This study was intended to find out fall and balance impairments in diabetic peripheral neuropathy patients. The study result shows adults with type 2 diabetes mellitus and neuropathy have significantly higher incidence of fall than those without type 2 diabetes mellitus. One of the commonly identified risk factors associated with falls is impaired balance. Balance impairment & subsequent increased fall risk in older adults with type 2 diabetes are most commonly associated with diabetic peripheral neuropathy. The devastating consequences of falls include decline in mobility, activity, avoidance, institutionalization& mortality.

2.2.3 Lim et al [2013][20]

This study compared the balance ability between patients with type 2 diabetes patients with and without peripheral neuropathy. They did a study with 60 subjects, 17 diabetic peripheral neuropathy patients, 25 diabetes patients, 18 subjects without diabetes. In this study they use balance master system to assess sensory impairment, motor impairment and functional limitations. Author concluded that functional limitations occur more in patients with peripheral neuropathy & dynamic balance stability decrease more with the patients with diabetes than with the subjects without diabetes.

2.2.4 M M Vaz et al [2013][26]

This study compared the postural control and functional strength between patients with type 2 diabetes patients with and without peripheral neuropathy. They did a study with 62 adults, age range 40-65 years, 32 individuals with type 2 diabetes mellitus [19 subjects without neuropathy&13 subjects with neuropathy] and 30 without diabetes mellitus. The main outcomes are upright balance (evaluated using modified CTSIB) functional strength (assessed with a five-time sit-to-stand test) postural control (asses using electromagnetic system), Time Up & Go test, Berg Balance Scale is also used to assess the balance. They found that subject with type 2 diabetes mellitus with or without diabetic neuropathy showed deficits in postural control& functional strength compared with healthy individuals of the same age group.

2.2.5 Hewston P et al [2015][33]

This study compared the sensory function, balance and mobility between patients with type 2 diabetes patients with and without peripheral neuropathy. They did a study with 35 diabetic peripheral neuropathy patients and 25 healthy subjects and assess the sensory function using biothesiometer, balance using activity-specific balance confidence, mobility disability using human activity profile-adjusted activity scores. They found that subject with type 2 diabetes mellitus with diabetic neuropathy showed deficits in sensory function, balance and mobility compared with healthy individuals of the same age group.

2.2.6 E M Gutierrez et al [2001][11]

The aim of this study was to find out the ankle motor functions of diabetic peripheral neuropathy patients. They did a study with six older women with diabetic neuropathy compared to six women without neuropathy, matched for age and presence of diabetes mellitus and nine healthy young women. Six component forceplate was used to measure three dimensional reaction forces and moments between the floor and foot while doing the balance challenging movements. They found that diabetic neuropathy leads to decrease in ankle strength and impairs balance

2.2.7 Salsich et al [2000][13]

This study compared the passive ankle stiffness in subject with diabetic peripheral neuropathy versus an age matched comparison group. They did a study with 17 patients with diabetes and peripheral neuropathy and 17 age-matched subjects and assessed passive ankle stiffness. A Kin-Com dynamometer is used to measure the passive ankle movements. They found that individual with diabetes and peripheral neuropathy have short versus stiff plantar flexor muscles, decreased dorsiflexion range of motion and decreased plantar flexor muscle excursion. This leads to balance impairment.

2.3 WEIGHT BEARING EXERCISES IN DIABETIC PERIPHERAL NEUROPATHY

2.3.1 M J Michael et al [2013][28]

This study compared the relative effectiveness of weight-bearing versus nonweight-bearing exercise for diabetic peripheral neuropathy patients. A randomized control trial was done with 29 participants with diabetes mellitus and peripheral neuropathy, 15 individual assigned to weight bearing exercise group and 14 individual assigned to nonweight bearing exercise group. They use 6 minute walk test as main outcome measure and found that people in the weight bearing exercise group showed greater gain in daily step count and 6 minute walk test compared with those in the nonweight bearing exercise group without improving the risk of foot ulceration.

2.3.2 L J. Tuttle et al [2012][24]

This study was intended to find out the best type of training approach for diabetic peripheral neuropathy patients. They analyse the effect of a moderate-intensity weight-bearing exercise program in diabetic peripheral neuropathy patients. They concluded that moderate-intensity exercise program help to improve some measure of muscle strength, physical function, and activity without causing injury in an individual with diabetic peripheral neuropathy

2.3.3 El- Abeer et al [2011][2]

The aim of this study was to establish whether proprioceptive training program on balance in patients with diabetic peripheral neuropathy improves sway indices and functional balance compared with conventional therapy. A randomized control trial was done with 28 diabetic peripheral neuropathy patients. The patients were recruited and equally divided in to two groups: proprioceptive training group and control group. Training was performed two times a week for 8 weeks. After the intervention, the subject in the intervention group shows improvement in functional balance, both static & dynamic balance compared with control group. They concluded that proprioceptive training with conventional physiotherapy improves functional balance in diabetic peripheral neuropathy patients

2.3.4 L.Allet et al [2010][21]

This study was to analyse the gait and balance after training with a set of exercise and to elucidate underlying mechanisms that contributed to the observed functional improvement in balance and gait. A randomized control trial was done with 107 diabetic peripheral neuropathy patients. Training was performed two times a week for 12 weeks. After the intervention, the subject in the intervention group shows increase in their habitual gait speed by 0.149 m/s and both static & dynamic balance compared with control group. They concluded that specific training inclusive of balance exercise and strength training using body weight can improve balance, gait speed and muscle strength.

2.3.5 R L Kruse et al [2010][37]

This study compared the relative effectiveness of strength and balance program training with conventional physical therapy following diabetic peripheral neuropathy. They did a 12 month randomised controlled trial with 79 people who were mostly sedentary, who had diabetes mellitus and peripheral neuropathy.38 individual assigned in control group and 41 in experimental group. They found that strength and balance program have effect in balance and lower extremity strength of diabetic peripheral neuropathy patients.

2.3.7 LeMaster et al [2008][19]

This study was to examine the incidence of foot ulcers in individuals with DPN who were assigned to a walking exercise group compared to a control group. This is a feet first randomized control study with 80 individuals with diabetes mellitus and peripheral neuropathy. Subjects were randomly assigned 39 individual as control group and 41 individual as intervention. Intervention components included leg strengthening and balance exercises; a graduated, self-monitored walking program, both group receive diabetic foot care education. After the intervention based on the result they concluded that assignment to the weight-bearing activity group did not increase the rate of foot ulcers.

2.4 MICHIGAN NEUROPATHY SCREENING INSTRUMEMT [MNSI]

2.4.1 A Moghtaderi et al [2013][5]

This study was to determine the diagnostic performance of the test characteristics and cut-off point of MNSI scoring for the diagnosis of diabetic peripheral neuropathy. They conducted a cross-section study over a two year period with 176 type 2 diabetic patients and found that accuracy of MNSI scoring makes it a useful screening test for diabetic neuropathy in taking a decision regarding which patients should be referred to a neurologist for electrophysiological studies. They suggest cut-off point of 2 for the MNSI procedure.

2.4.2 M Lunetta et al [2012][25]

This study was to determine the reliability and reproducibility of Michigan neuropathy screening instrument [MNSI]. They evaluated on 80 diabetic patients MNSI consisted sum of scores varying from 0- 1 for each abnormality revealed in foot appearance, Achilles reflexes present and vibratory threshold [VPT]. MNSI score of 2-5 as cut-off may be considered a rapid, simple, reproducible and reliable test for rapid ambulatory screening of peripheral diabetic neuropathy.

2.4.3 Herman et al [2012][46]

This study was to evaluate the performance of the MNSI in detecting the peripheral neuropathy in patients with Type 2 diabetes. They used cut point >2 in MNSI for confirming the peripheral neuropathy The MNSI is a simple, non-invasive and valid measure of peripheral neuropathy in Type 2 diabetes.

2.5 SHARPEN ROMBERG TEST

2.7.1 Gras et al [2015][23]

This study was to determine the effect of sharpened Romberg test associated with fall risk, mobility, and gait measures. They did the study with 34 adults with diabetic peripheral neuropathy and revealed the ability to attain and hold the tandem stance position for the sharpened Romberg is associated with low fall risk. The sharpened Romberg can serve as a quick balance screen that requires minimal space and equipment.

2.7.2 Laura et al [2016][22]

This study was to done to examine the convergent validity of the Sharpened Romberg (SR) as a measure of balance for diabetic peripheral neuropathy patients. They include 100 adults with diabetic peripheral neuropathy and performed the SR with eyes open and closed, the Berg Balance Scale, (BBS), Timed Up-and-Go (TUG), and 10-MeterWalk.Sharpen Romberg test with eyes open was strongly correlated with the BBS and TUG and moderately correlated with the 10-Meter Walk. For the eyes open test, 73 participants completed 30 s; 19 less than 30 s; and 8 could not attain the position, with significant group differences for all measures. Based on the result they conclude that the sharpen Romberg test is a valid balance test.

2.6 TIMED UP & GO TEST

2.6.1 S D Jernigan et al [2012][42]

This study was to identify which of 4 functional mobility fall risk assessment tools best discriminates in people with diabetic peripheral neuropathy between recurrent fallers and those who are not recurrent fallers. Fall risk was assessed using the functional reach test, the timed-Up& Go test, the berg balance scale and the dynamic gait index. Ten of the 36 participants were classified as recurrent fallers when traditional cut-off scores were used, the dynamic gait index and functional reach test demonstrated the highest sensitivity at only 30%. The dynamic gait index also demonstrated the highest overall diagnostic accuracy. When modified cut-off scores were used, all tools demonstrated improved sensitivity (80% or 90%).overall diagnostic accuracy improved for all tests. except the functional reach test. The timed Up& Go test demonstrated the highest diagnostic accuracy at 88.9%.

2.6.2 E Nordin et al [2010][12]

This study was to evaluate and compare the prognostic validity relative to falls of the Timed Up& Go test[TUG], a modified Get Up & Go test[GUG-M] . 53% of the participants fell at least once. Various cut-off values of the TUG [12, 15, 20, 25,30,35,40 seconds] and GUG-M showed LR+ between 0.9 and 2.6, LR- between 0.1 and 1.0. TUG test score less than 13.5 seconds gives guidance in ruling out a high fall risk but insufficient information in ruling in such a risk. The grading of fall risk by GUG-M appears of very limited value.

2.7 BIOTHESIOMETER

2.5.1 Tewari et al [2014][45]

This study was to evaluate the impaired redistribution of plantar pressure in diabetes peripheral neuropathy patients. Increased plantar pressure makes the diabetic subjects prone to foot ulcers which are attributable to various anatomical factors like changes in foot architecture; loss of arch, muscle atrophy etc. biothesiometer is an effective tool for finding the occurrences of ulcer. Abnormal foot pressure can be reduced by using special footwear, off-loading modalities such as accommodative dressing, walking splint etc.

2.5.2 J A Temlett [2012][17]

This study was for assessing vibration threshold using biothesiometer compared to a C128-HZ tuning fork. Great toe, metatarsal heads are the common place for checking the vibration using biothesiometer. Biothesiometer was a more accurate gauge of vibration threshold and it gives a quantitative measure. The study shows biothesiometer is more accurate to measure the vibratory perception compared to a timed tuning fork.

2.5.3 A P Garrow& A J M Bouton [2010][1]

This study suggest that vibration perception threshold [VPT] measure can be used to easily and accurately identify at risk diabetic patients, including those with early neuropathic deficits. The VPT testing into clinical practice has the potential to significantly improve the outcome in patients with diabetic peripheral neuropathy.

3. AIM AND OBJECTIVES

3.1 AIM

To find out the effectiveness of lower extremity weight bearing training along with the conventional training to improve balance, vibration perception and ankle mobility in diabetic peripheral neuropathy patients**.**

3.2 OBJECTIVES

- To evaluate the effectiveness of lower extremity weight bearing training along with conventional training to improve static balance in patients with diabetic peripheral neuropathy
- To evaluate the effectiveness of lower extremity weight bearing training along with the conventional training to improve dynamic balance in patients with the diabetic peripheral neuropathy
- To evaluate the effectiveness of lower extremity weight bearing training along with conventional training to improve vibration perception in patients with diabetic peripheral neuropathy
- To evaluate the effectiveness of lower extremity weight bearing training along with conventional training to improve ankle range of motion in patients with diabetic peripheral neuropathy
- To evaluate the effectiveness of conventional training alone to improve static balance in patients with diabetic peripheral neuropathy
- To evaluate the effectiveness of conventional training alone to improve dynamic balance in patients with diabetic peripheral neuropathy
- To evaluate the effectiveness of conventional training alone to improve vibration perception in patients with diabetic peripheral neuropathy
- To evaluate the effectiveness of conventional training alone to improve ankle range of motion in patients with diabetic peripheral neuropathy
- To compare the effectiveness between lower extremity weight bearing exercise and conventional training to improve the balance, vibration perception and ankle mobility in patients with diabetic peripheral neuropathy.

4. METHODOLOGY

4.1 RESEARCH DESIGN

- Quasi- experimental design

4.2 SAMPLING TECHNIQUE

- Non probability purposive sampling

4.3 STUDY POPULATION

- Type 2 diabetic patients with more than 10 years history

4.4 SAMPLE SIZE

- Total 30 patients
- Group A [experimental group]-15 patients
- Group B [control group] - 15 patients

4.5SAMPLING CRITERIA:

INCLUSION CRITERIA

- Individual with type two diabetes mellitus more than 10 year history
- Michigan neuropathy screening instrument > 2
- Both sex –male & female
- Age 40-65
- Vibration perception threshold value : 20V -- 50V

EXCLUSION CRITERIA

- Diabetic ulcer in either foot
- Uncontrolled blood sugar
- Central nervous system illness that can affect balance
- Musculoskeletal problems involving trunk and lower limbs
- Severe pain influencing balance
- Rheumatoid arthritis patients

- Severe visual and hearing deficit
- Symptomatic postural hypotension
- Cardiovascular patients

4.6 STUDY DURATION

- 1 Year

4.7 STUDY SETTING

- Department of Physical Medicine and Rehabilitation, Kovai Medical Center & Hospital, Coimbatore

4.8STUDY APPROVAL

- Study done was approved by the KMCH Ethics Committee, Kovai Medical Center and Hospital

4.9 HYPOTHESES

4.9.1 NULL HYPOTHESES

- **H_{01}:** There is no significant effect of lower extremity weight bearing training along with conventional training to improve static balance in patients with diabetic peripheral neuropathy
- **H_{02}:** There is no significant effect of lower extremity weight bearing training along with conventional training to improve dynamic balance in patients with diabetic peripheral neuropathy
- **H_{03}:** There is no significant effect of lower extremity weight bearing training along with conventional training to improve vibration perception in patients with diabetic peripheral neuropathy
- **H_{04}:** There is no significant effect of lower extremity weight bearing training along with conventional training to improve ankle range of motion in patients with diabetic peripheral neuropathy
- **H_{05}:** There is no significant effect of conventional training alone to improve static balance in patients with diabetic peripheral neuropathy.
- **H_{06}:** There is no significant effect of conventional training alone to improve dynamic balance in patients with diabetic peripheral neuropathy.

- **H_{07}:** There is no significant effect of conventional training alone to improve vibration perception in patients with diabetic peripheral neuropathy.
- **H_{08}:** There is no significant effect of conventional training alone to improve ankle range of motion in patients with diabetic peripheral neuropathy.
- **H_{09}:** There is no significant difference between the group receiving lower extremity weight bearing exercise along with conventional training and the group receiving conventional training in patients with diabetic peripheral neuropathy.

4.9.2 ALTERNATE HYPOTHESES

- **H_{A1}:** There is a significant effect of lower extremity weight bearing training along with conventional training to improve static balance in patients with diabetic peripheral neuropathy
- **H_{A2}:** There is a significant effect of lower extremity weight bearing training along with conventional training to improve dynamic balance in patients with diabetic peripheral neuropathy
- **H_{A3}:** There is a significant effect of lower extremity weight bearing training along with conventional training to improve vibration perception in patients with diabetic peripheral neuropathy
- **H_{A4}:** There is a significant effect of lower extremity weight bearing training along with conventional training to improve ankle range of motion in patients with diabetic peripheral neuropathy
- **H_{A5}:** There is a significant effect of conventional training alone to improve static balance in patients with diabetic peripheral neuropathy.
- **H_{A6}:** There is a significant effect of conventional training alone to improve dynamic balance in patients with diabetic peripheral neuropathy.
- **H_{A7}:** There is a significant effect of conventional training alone to improve vibration perception in patients with diabetic peripheral neuropathy.
- **H_{A8}:** There is a significant effect of conventional training alone to improve ankle range of motion in patients with diabetic peripheral neuropathy.
- **H_{A9}:** There is a significant difference between the group receiving lower extremity weight bearing exercise along with conventional training and the group receiving conventional training in patients with diabetic peripheral neuropathy.

4.10 OUTCOME MEASURES

- Static balance
- Dynamic balance
- Vibration perception
- Ankle range of motion

4.11 MEASUREMENT TOOLS

- Sharpened Romberg test
- Timed up & go test
- Biothesiometer
- Goniometer

4.12 TREATMENT DURATION

- **CONTROL GROUP:**
  - 4 alternative days in a week for 8 weeks.
  - 3 sets of 6 exercise being done for a period of 20-30 minutes with a rest period of 1 minute between each set. One set contain ten repetitions of exercise.

- **EXPERIMENTAL GROUP:**
  - 4 alternative days in a week for 8 weeks
  - The exercises given for control group and additional 3 sets of each weight bearing exercises being done. The total duration of all exercises is for a period of 45-50 minutes with a rest period of 1 minute between each set. One set contains ten repetitions of exercise.

4.13 TREATMENT PROCEDURE

Exercises were home exercise which the patient should do in their own home setups, and maintain record of exercise training on the form which is given along with the pamphlet. Patients were advised to use MCR Chapal, check the foot before and after the each session and avoid slippery surface.

4.13.1CONVENTIONAL TREATMENT

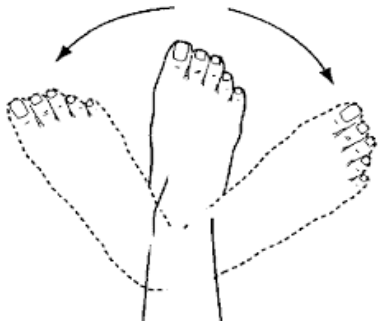
Warm up [open chain ankle range of motion exercise] subject wrote the alphabet in the air with each foot by moving ankle.

1. DEEP BREATHING EXERCISE

- Patient should be in relaxed position either sitting or lying
- Take deep inspiration through nose and expire through mouth
- 10 repetitions in one set do 3 sets.

2. RANGE OF MOTION EXERCISE OF BILATERAL ANKLE

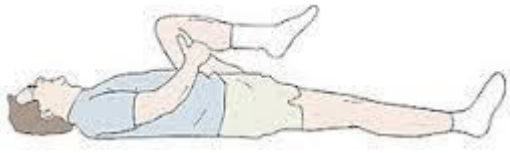
Ankle dorsiflexion/plantarflexion



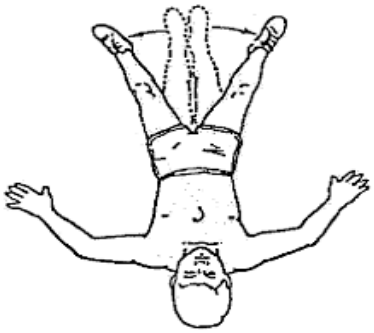
Ankle inversion/eversion

- Patient should be in relaxed position either sitting or lying
- Do bilateral ankle movements: plantar flexion, dorsiflexion, inversion, and eversion in pain free range of motion
- 10 repetitions in one set do 3 sets.

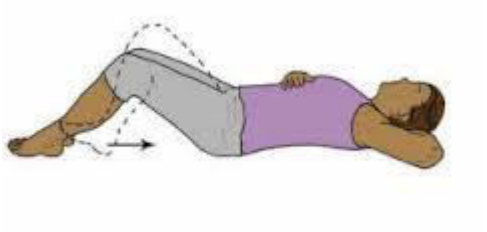
3. RANGE OF MOTION EXERCISE OF BILATERAL HIP AND KNEE



Hip flexion/extension



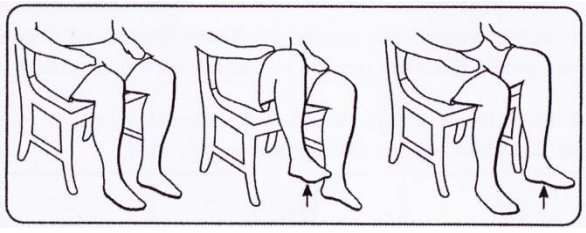
Hip abduction/adduction



Knee flexion/extension

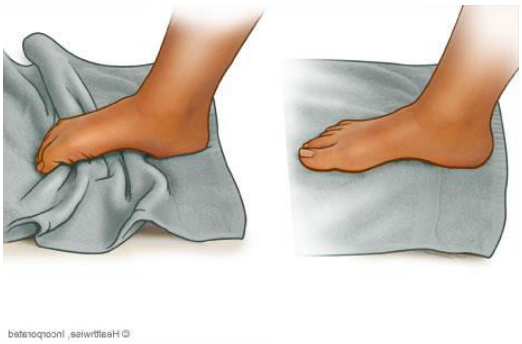
- Patient should be in supine lying
- Do bilateral hip & knee movements: hip flexion/extension, abduction/ adduction, external /internal rotations
- Knee flexion/ extension
- Do in pain free range of motion
- Each exercise 10 repetitions in one set do 3 sets.

4. SPOT MARCHING



- Patient should be in relaxed sitting position
- Do 10 counts in one set do 3 sets

5. GRASPING THE TOWEL WITH TOES IN THE FLOOR



- Patient should be in sitting posture
- 10 repetitions in one set do 3 sets.

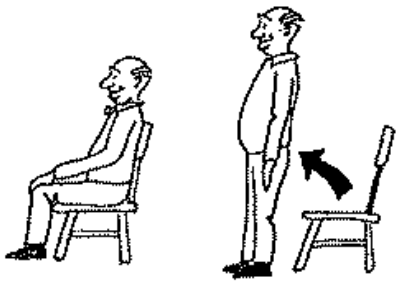
4.13.2 EXPERIMENTAL GROUP

Warm up [open chain ankle rom exercises] subject wrote the alphabet in the air with each foot by moving ankle

LEVEL 1 [1-2 WEEKS]

- Do the same conventional treatment

1. SIT-TO-STAND ACTIVITY



- Use back supported chair
- Patient feet kept shoulder width apart
- 10 repetitions in one set do 3 sets.

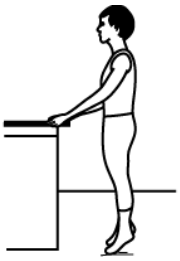
2. WEIGHT SHIFTING

- Stand with wide base of support
- Shift the weight in to both legs do not take off the legs from floor
- 10 repetitions in one set do 3 sets.

3. SQUATTING

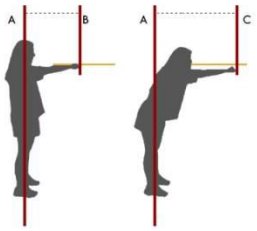
- With both hand support
- Patient feet kept shoulder width apart
- 5 seconds hold the squatting position then get up
- 10 repetitions in one set do 3 sets.

4. BIPEDAL HEEL RAISE



- With hand support
- 10 repetitions in one set do 3 sets.

5. FUNCTIONAL REACHING

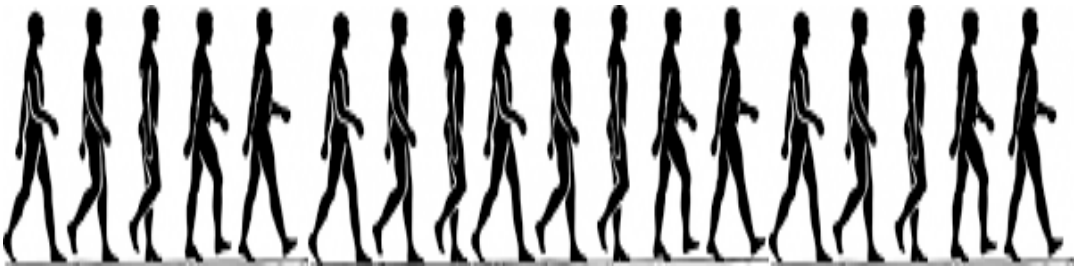


- Anteriorly& sideways lean for touching targets[45 cm first gradually increase the distance ,1meter and 1.5 meter]
- 10 repetitions in one set do 3 sets.

6. UNIPEDAL/ONE LEG STANDING

- With both hand support
- Ask the patient to stand at least 10 seconds initially
- 10 repetitions in one set do 3 sets.

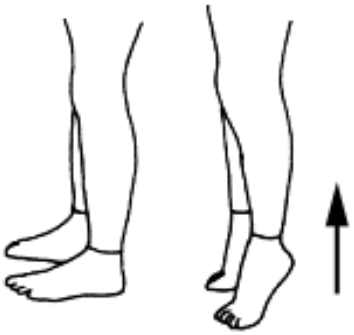
7. WALKING



- 5 minutes warm up
- 5 minutes walking
- Gradually increase the speed of walking
- 5 minutes cool down gradually decrease the speed of walking
- Teach the patients to check the pulse rate if pulse rate increases more than the normal level stop walking and advice to take rest.

LEVEL 2[3-4 WEEKS]

1. BIPEDAL HEEL RAISE



HEEL RAISES

- With one hand support
- 10 repetitions in one set do 3 sets.

2. TOE RAISE

- With one hand support
- 10 repetitions in one set do 3 sets.

3. SQUATTING

- With one hand support
- Patient feet kept shoulder width apart
- 15 seconds hold the squatting position then get up
- 10 repetitions in one set do 3 sets.

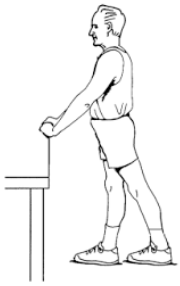
4. ONE LEG STANDING/UNIPEDAL STANDING

- With one hand support if necessary
- Ask the patient to stand in one leg at least for 15 seconds
- 10 repetitions in one set do 3 sets.

5. UNIPEDAL STAND OVER PILLOW

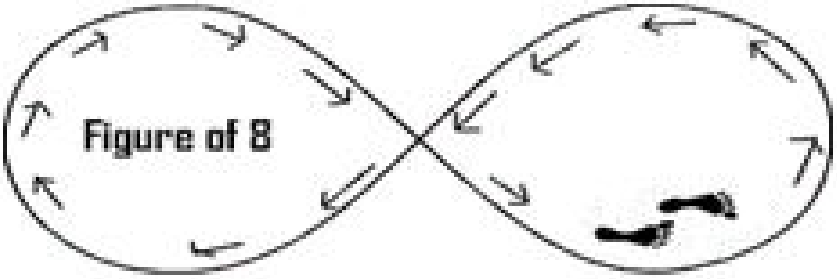
- With hand support
- Ask the patient to stand at least 10 sec
- 10 repetitions in one set do 3 sets.

6. TANDEM STANDING



- with hand support if necessary
- Ask the patient to stand at least 10 seconds
- 10 repetitions in one set do 3 sets.

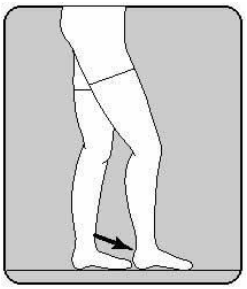
7. WALKING IN FIGURE OF EIGHT



- Walk with one hand support
- 5 repetitions in one set do 3 sets

LEVEL 3 [5-6 WEEKS]

1. TANDEM STANDING



- Without support
- Ask the patient to stand at least 15 seconds
- 10 repetitions in one set do 3 sets.

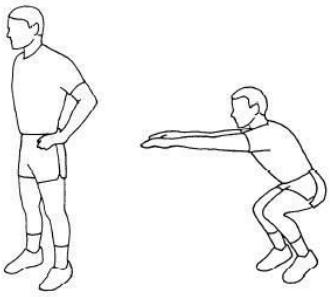
2. UNIPEDAL STAND OVER PILLOW

- Without hand support
- Ask the patient to stand at least 15 sec
- 10 repetitions in one set do 3 sets.

3. TOE RAISE

- Without hand support
- 10 repetitions in one set do 3 sets.

4. SQUATTING



- Without support
- Patient feet kept shoulder width apart
- 20 seconds hold the squatting position then get up
- 10 repetitions in one set do 3 sets.

5. TANDEM WALKING

- With one hand support
- Walk for 3 meter
- Do twice.

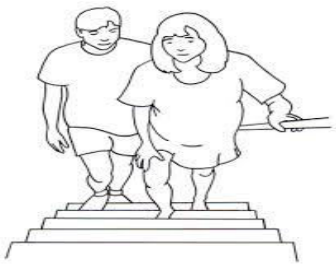
6. TOE WALK

- With hand support
- Walk for 3 meter
- Do twice.

7. BACK WARD WALKING

- With one hand support
- Walk 3 meter
- Do twice.

8. STAIR CLIMBING



- With one hand support
- 10 steps up & down
- Do twice.

LEVEL 4 [7-8 WEEKS]

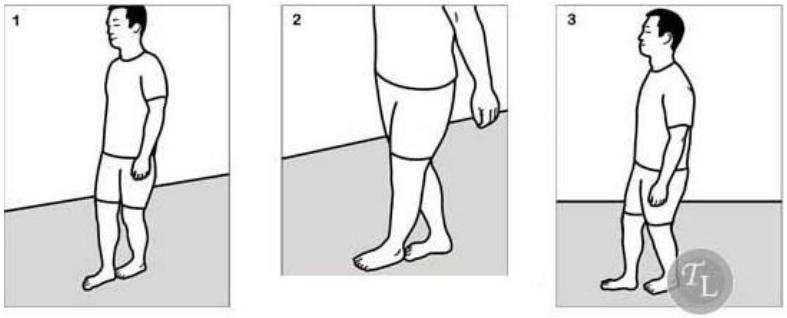
1. STANDING ARM /LEG MARCH

- Do 10 counts in one set do 3 sets.

2. STEP SIDEWAYS

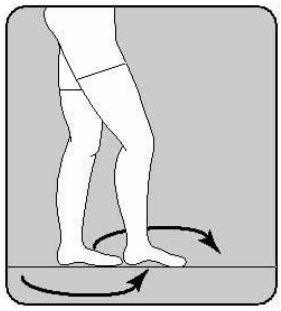
- Walk for 3 meters
- Without hand support
- Do both side
- Do twice.

3. TANDEM WALKING



- Without hand support
- Walk for 3 meter
- Do twice.

4. CROSS OVER WALK



- Walk for 3 meters
- Do twice.

5. TOE WALK

- Without hand support
- Walk for 3 meter
- Do twice.

6. BACKWARD WALKING

- Without support
- Walk for 3 meters
- Do twice

7. STAIR CLIMBING

- Without hand support
- 20 steps up and down
- Do twice.

4.14 PHOTOGRAPHIC PRESENTATION

Figure 4.1 Vibration perception

Figure 4.2 Biothesiometer

Figure 4.3 Sharpen Romberg test

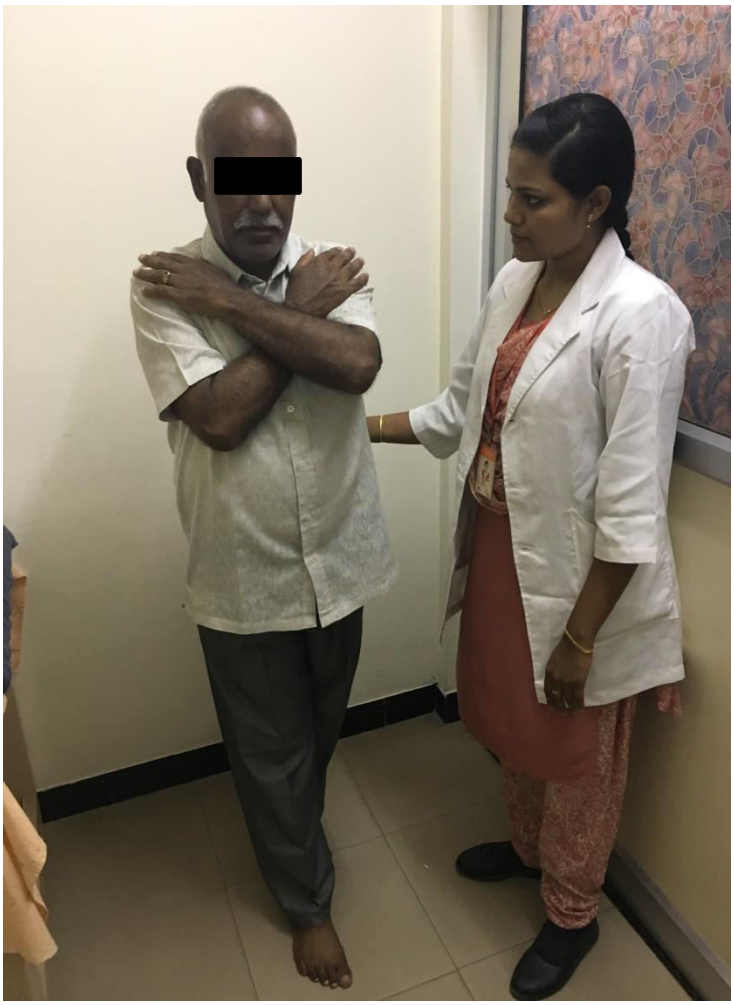


Figure 4.4 Active angle range of motion

4.15 STATISTICAL TOOL

a) Paired ‘t’ Test

b) Independent ‘t’ Test

- **PAIRED ‘t’ TEST (within groups)**

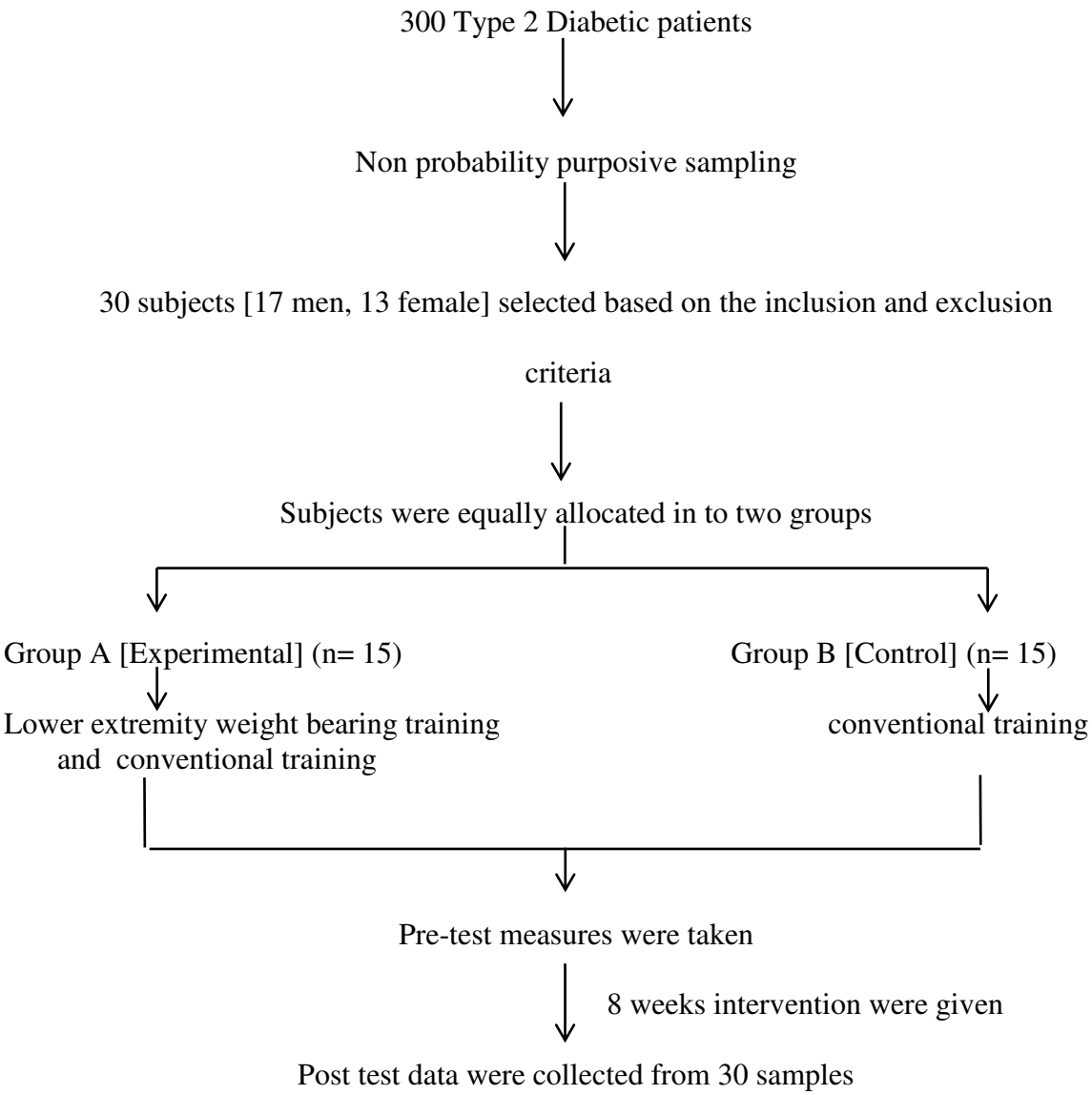
$$\mathbf{t} = \frac{\bar{d}\sqrt{n}}{S} \qquad \text{Where, S} = \sqrt{\frac{\sum d^2 - \left[\bar{d}\right]^2 \times n}{n-1}}$$

- **INDEPENDENT ‘t’ TEST (between groups)**

$$t = \frac{\overline{X1} - \overline{X2}}{S}\sqrt{\frac{n_1 n_2}{(n_1+n_2)}} \qquad \text{Where, } S = \sqrt{\frac{\sum d_1^2 + \sum d_2^2}{n_1 + n_2 - 2}}$$

- **S** = Combined standard deviation
- **d_1 & d_2** = difference between initial and final readings in group A& B
- **n_1 & n_2**= number of patients in group A & group B
- **X_1 & X_2** = mean of group A & group B

4.16 FLOW CHART



5. DATA PRESENTATION

5.1 TABULAR PRESENTATION

Table 5.1: DEMOGRAPHIC DATA OF THE STUDY POPULATION

DEMOGRAPHIC VARIABLES	GROUP A (EXPERIMENTAL)		GROUP B (CONTROL)	
AGE (Mean value)	56.53		57.73	
GENDER (Percentage)	MALE	60%	MALE	53.4%
	FEMALE	40%	FEMALE	46.6%
MNSI (Mean value)	2.8		2.7	
DURATION OF DIABETES (Mean value)	15.6		15.4	
HbA1C (Mean value)	6.8		6.9	

MNSI: Michigan neuropathy screening instrument
HbA1C: Glycosylated Hemoglobin

PAIRED ‘t’ TEST

GROUP A = EXPERIMENTAL GROUP B = CONTROL

Table 5.2: STATIC BALANCE: GROUP A

OUTCOME MEASURE	MEAN VALUE		Calculated ‘t’ Value	Table ‘t’ Value	Level of Significance
	PRE TEST	POST TEST			
SHARPEN ROMBERG TEST	10.56	20.54	26.89	2.14	p<0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table ‘t’ value is 2.14 and the calculated ‘t’ value is 26.89 for static balance using Sharpen Romberg Test score. Since the calculated ‘t’ value is more than the table ‘t’ value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A1} - There is a significant effect of lower extremity weight bearing training along with conventional training to improve static balance in patients with diabetic peripheral neuropathy).

Table 5.3: STATIC BALANCE: GROUP B

OUTCOME MEASURE	MEAN VALUE		Calculated ‘t’ Value	Table ‘t’ Value	Level of Significance
	PRE TEST	POST TEST			
SHARPEN ROMBERG TEST	11.37	13.65	10.15	2.14	p<0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table ‘t’ value is 2.14 and the calculated ‘t’ value is 10.15 for static balance using Sharpen Romberg Test score. Since the calculated ‘t’ value is more than the table ‘t’ value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A5} - There is a significant effect of conventional training alone to improve static balance in patients with diabetic peripheral neuropathy).

Table 5.4: DYNAMIC BALANCE: GROUP A

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
TUG TEST	19.26	13.5	27.8	2.14	p <0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 27.8 for dynamic balance using Tug Test Score. Since the calculated 't' value is more than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A2} - There is a significant effect of lower extremity weight bearing training along with conventional training to improve dynamic balance in patients with diabetic peripheral neuropathy).

Table 5.5: DYNAMIC BALANCE: GROUP B

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
TUG TEST	19.44	16.91	12.73	2.14	p<0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 12.73 for dynamic balance using Tug Test Score. Since the calculated 't' value is more than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A6} - There is a significant effect of conventional training alone to improve dynamic balance in patients with diabetic peripheral neuropathy).

Table 5.6: VIBRATION PERCEPTION: GROUP A

Table 5.6.1:RIGHT FOOT

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
VIBRATION PERCEPTION	22.3	17.33	12.07	2.14	p <0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 12.07 for vibration perception using biothesiometer score. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A3} There is a significant effect of lower extremity weight bearing training along with conventional training to improve vibration perception in patients with diabetic peripheral neuropathy).

Table 5.6.2: LEFT FOOT

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
VIBRATION PERCEPTION	22.53	17.4	16.74	2.14	p <0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 16.74 for vibration perception using biothesiometer score. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A3} There is a significant effect of lower extremity weight bearing training along with conventional training to improve vibration perception in patients with diabetic peripheral neuropathy)

Table 5.7: VIBRATION PERCEPTION: GROUP B

Table 5.7.1: RIGHT FOOT

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
VIBRATION PERCEPTION	23	20.2	2.11	2.14	p > 0.05 Not Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 2.11 for vibration perception using biothesiometer score. Since the calculated 't' value is less than the table 't' value, null hypothesis is accepted (H_{07} - There is no significant effect of conventional training alone to improve vibration perception in patients with diabetic peripheral neuropathy).

Table 5.7.2:LEFT FOOT

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
VIBRATION PERCEPTION	23.2	20.6	2.12	2.14	p >0.05 Not Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 2.12 for vibration perception using biothesiometer score. Since the calculated 't' value is less than the table 't' value, null hypothesis is accepted (H_{07} - There is no significant effect of conventional training alone to improve vibration perception in patients with diabetic peripheral neuropathy).

Table 5.8:ANKLE MOBILITY: GROUP A

Table 5.8.1:PLANTAR FLEXION: RIGHT LEG

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
ANGLE MOBILITY	33.53	45.4	15.48	2.14	p <0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 15.48 for plantarflexion using goniometer. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A4} - There is a significant effect of lower extremity weight bearing training along with conventional training to improve ankle range of motion in patients with diabetic peripheral neuropathy).

Table 5.8.2:PLANTAR FLEXION: LEFT LEG

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
ANGLE MOBILITY	33.28	46.78	15.49	2.14	p <0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 15.49 for plantarflexion using goniometer. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A4} - There is a significant effect of lower extremity weight bearing training along with conventional training to improve ankle range of motion in patients with diabetic peripheral neuropathy).

Table 5.8.3: DORSIFLEXION: RIGHT LEG

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
ANGLE MOBILITY	11.53	18.6	19.73	2.14	p <0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 19.73 for dorsiflexion using goniometer. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A4} - There is a significant effect of lower extremity weight bearing training along with conventional training to improve ankle range of motion in patients with diabetic peripheral neuropathy).

Table 5.8.4: DORSIFLEXION: LEFT LEG

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
ANGLE MOBILITY	11.48	17.9	19.75	2.14	p <0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 19.75 for dorsiflexion using goniometer. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A4} - There is a significant effect of lower extremity weight bearing training along with conventional training to improve ankle range of motion in patients with diabetic peripheral neuropathy).

Table 5.9:ANKLE MOBILITY: GROUP B

Table 5.9.1:PLANTAR FLEXION: RIGHT LEG

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
ANGLE MOBILITY	31.66	35.66	7.25	2.14	p <0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 7.25 for plantarflexion using goniometer. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A8} - There is a significant effect of conventional training alone to improve ankle range of motion in patients with diabetic peripheral neuropathy).

Table 5.9.2: PLANTAR FLEXION: LEFT LEG

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
ANGLE MOBILITY	32.01	36.01	7.28	2.14	p <0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 7.28 for plantarflexion using goniometer. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A8} There is a significant effect of conventional training alone to improve ankle range of motion in patients with diabetic peripheral neuropathy).

Table 5.9.3: DORSIFLEXION: RIGHT LEG

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
ANGLE MOBILITY	12.33	15.6	9.73	2.14	p <0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 9.73 for dorsiflexion using goniometer. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A8} There is no significant effect of conventional training alone to improve ankle range of motion in patients with diabetic peripheral neuropathy).

Table 5.9.4:DORSIFLEXION: LEFT LEG

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	PRE TEST	POST TEST			
ANGLE MOBILITY	12.00	14.7	9.76	2.14	p <0.05 Significant

For 14 degrees of freedom at 5 % level of significance, the table 't' value is 2.14 and the calculated 't' value is 9.76 for dorsiflexion using goniometer. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A8} - There is a significant effect of conventional training alone to improve ankle range of motion in patients with diabetic peripheral neuropathy).

INDEPENDENT ‘t’ TEST

GROUP A = EXPERIMENTAL GROUP B = CONTROL

Table 5.10: STATIC BALANCE

Table 5.10.1: PRETEST

OUTCOME MEASURE	MEAN VALUE		Calculated ‘t’ Value	Table ‘t’ Value	Level of Significance
	Group A	Group B			
SHARPEN ROMBERG TEST	10.56	11.37	1.46	2.04	p > 0.05 Not Significant

For 28 degrees of freedom at 5 % level of significance, the table ‘t’ value is 2.04 and the calculated ‘t’ value is 1.46 for static balance using Sharpen Romberg Test. Since the calculated ‘t’ value is less than the table ‘t’ value, null hypothesis is accepted (H_{09} - There is no significant difference exists in static balance between Group A and Group B)

Table 5.10.2: POSTTEST

OUTCOME MEASURE	MEAN VALUE		Calculated ‘t’ Value	Table ‘t’ Value	Level of Significance
	Group A	Group B			
SHARPEN ROMBERG TEST	20.54	13.65	12.51	2.04	p <0.05 Significant

For 28 degrees of freedom at 5 % level of significance, the table ‘t’ value is 2.04 and the calculated ‘t’ value is 12.51 for static balance using Sharpen Romberg Test score. Since the calculated ‘t’ value is more than the table ‘t’ value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A9} -There is a significant difference exists in static balance between Group A and Group B).

Table 5.11: DYNAMIC BALANCE

Table 5.11.1: PRETEST

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
TUG TEST	19.26	19.44	0.32	2.04	p > 0.05 Not Significant

For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 0.32 for dynamic balance using Tug Test Score. Since the calculated 't' value is less than the table 't' value, null hypothesis is accepted (H_{09} - There is no significant difference exists in dynamic balance between Group A and Group B).

Table 5.11.2: POSTTEST

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
TUG TEST	13.5	16.91	8.81	2.04	p <0.05 Significant

For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 8.81 for dynamic balance using Tug Test Score. Since the calculated 't' value is more than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A9} -There is a significant difference exists between in dynamic balance between Group A and Group B).

Table 5.12: VIBRATION PERCEPTION: RIGHT FOOT

Table 5.12.1: PRETEST

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
VIBRATION PERCEPTION	22.3	23	0.93	2.04	p > 0.05 Not Significant

For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 0.93 for vibratory perception using biothesiometer score. Since the calculated 't' value is less than the table 't' value, null hypothesis is accepted (H_{09} There is no significant difference exists in vibratory perception between Group A and Group B).

Table 5.12.2: POSTTEST

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
VIBRATION PERCEPTION	17.33	20.2	4.48	2.04	p <0.05 Significant

For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 4.48 for vibratory perception using Biothesiometer Score. Since the calculated 't' value is more than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A9} - There is a significant difference exists in vibratory perception between Group A and Group B).

Table 5.13: VIBRATION PERCEPTION: LEFT FOOT

Table 5.13.1: PRETEST

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
VIBRATION PERCEPTION	22.53	23.2	0.92	2.04	p > 0.05 Not Significant

For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 0.92 for vibratory perception using biothesiometer score. Since the calculated 't' value is less than the table 't' value, null hypothesis is accepted (H_{09} - There is no significant difference exists in vibratory perception between Group A and Group B).

Table 5.13: POSTTEST

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
VIBRATION PERCEPTION	17.4	20.6	4.52	2.04	p <0.05 Significant

For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 4.52 for vibratory perception using Biothesiometer Score . Since the calculated 't' value is more than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A9} - There is a significant difference exists in vibratory perception between Group A and Group B).

Table 5.14: ANKLE MOBILITY

Table 5.14.1: PLANTAR FLEXION: RIGHT LEG

a) PRETEST

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
ANGLE MOBILITY	33.53	31.66	1.91	2.04	p > 0.05 Not Significant

For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 1.91 for plantarflexion using goniometer. Since the calculated 't' value is less than the table 't' value, null hypothesis is accepted (H_{09} - There is no significant difference exists in ankle range of motion between Group A and Group B).

b) POSTTEST

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
ANGLE MOBILITY	45.4	35.66	7.23	2.04	p <0.05 Significant

For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 7.23 for plantarflexion using goniometer. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A9} -There is a significant difference exists in ankle range of motion between Group A and Group B).

Table 5.14.2: PLANTAR FLEXION: LEFT LEG

a) PRETEST

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
ANGLE MOBILITY	33.28	32.01	1.90	2.04	p > 0.05 Not Significant

For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 1.90 for plantarflexion using goniometer. Since the calculated 't' value is less than the table 't' value, null hypothesis is accepted (H_{09} - There is no significant difference exists in ankle range of motion between Group A and Group B).

b) POSTTEST

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
ANGLE MOBILITY	46.78	36.01	7.25	2.04	p <0.05 Significant

For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 7.25 for plantarflexion using goniometer. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A9} - There is a significant difference exists in ankle range of motion between Group A and Group B).

Table 5.14.3: DORSIFLEXION : RIGHT LEG

a) **PRETEST**

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
ANGLE MOBILITY	11.53	12.33	1.81	2.04	p > 0.05 Not Significant

For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 1.81 for dorsiflexion using goniometer. Since the calculated 't' value is less than the table 't' value, null hypothesis is accepted (H_{09} - There is no significant difference exists in ankle range of motion between Group A and Group B)

b) POSTTEST

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
ANGLE MOBILITY	18.6	15.6	5.96	2.04	p <0.05 Significant

For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 5.96 for dorsiflexion using goniometer. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A9} - There is a significant difference exists in ankle range of motion between Group A and Group B).

Table 5.14.4: DORSIFLEXION: LEFT LEG

a) PRETEST

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
ANGLE MOBILITY	11.48	12.00	1.82	2.04	p > 0.05 Not Significant

For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 1.82 for dorsiflexion using goniometer. Since the calculated 't' value is less than the table 't' value, null hypothesis is accepted (H_{09} - There is no significant difference exists in ankle range of motion between Group A and Group B)

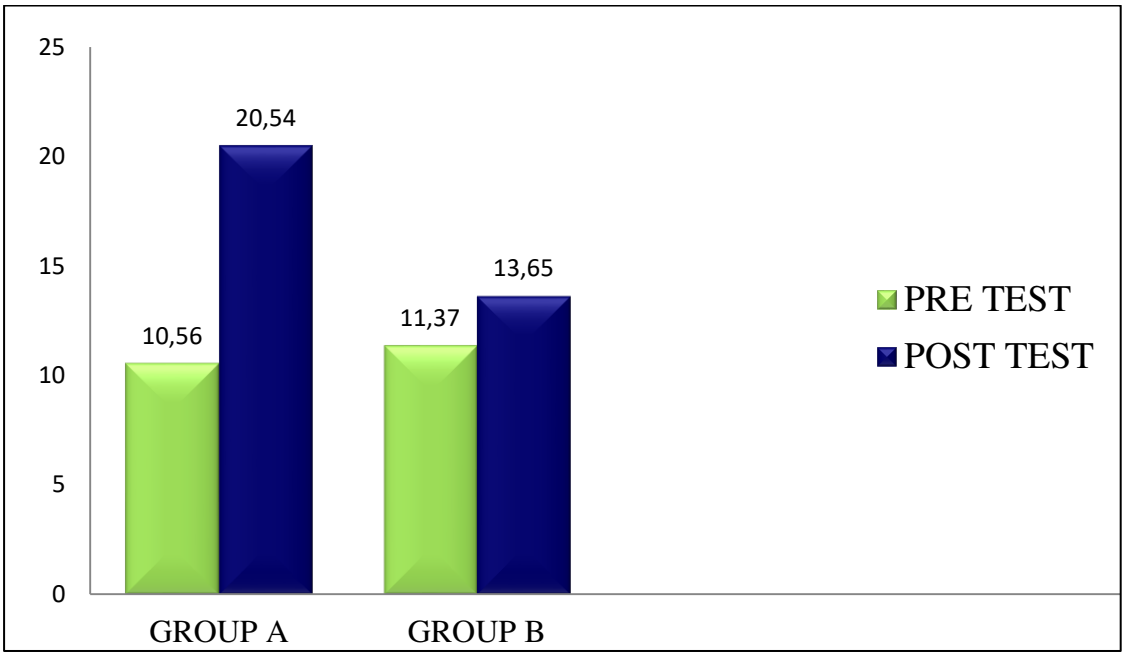
b) POSTTEST

OUTCOME MEASURE	MEAN VALUE		Calculated 't' Value	Table 't' Value	Level of Significance
	Group A	Group B			
ANGLE MOBILITY	17.9	14.7	5.99	2.04	p <0.05 Significant

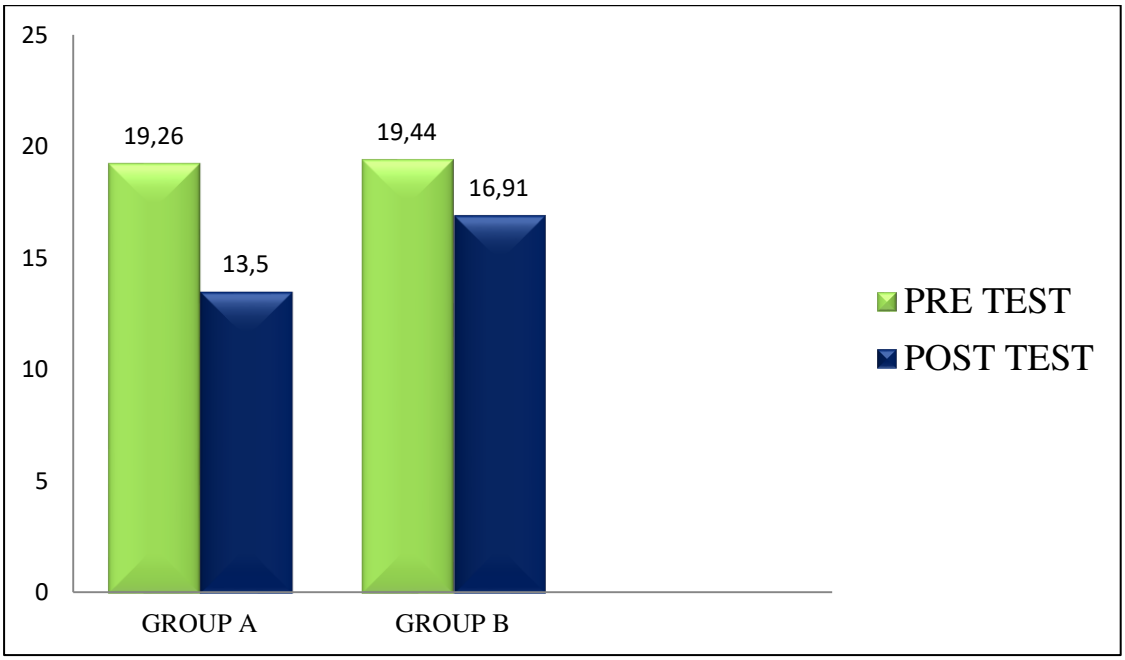
For 28 degrees of freedom at 5 % level of significance, the table 't' value is 2.04 and the calculated 't' value is 5.99 for dorsiflexion using goniometer. Since the calculated 't' value is greater than the table 't' value, null hypothesis is rejected and alternate hypothesis is accepted (H_{A9} - There is a significant difference exists in ankle range of motion between Group A and Group B).

5.2 GRAPHICAL REPRESENTATION

Graph 5.1: STATIC BALANCE: GROUP A & GROUP B
Mean Value Changes in Sharpen Romberg test score for Both Group A (Experimental) and Group B (Control)

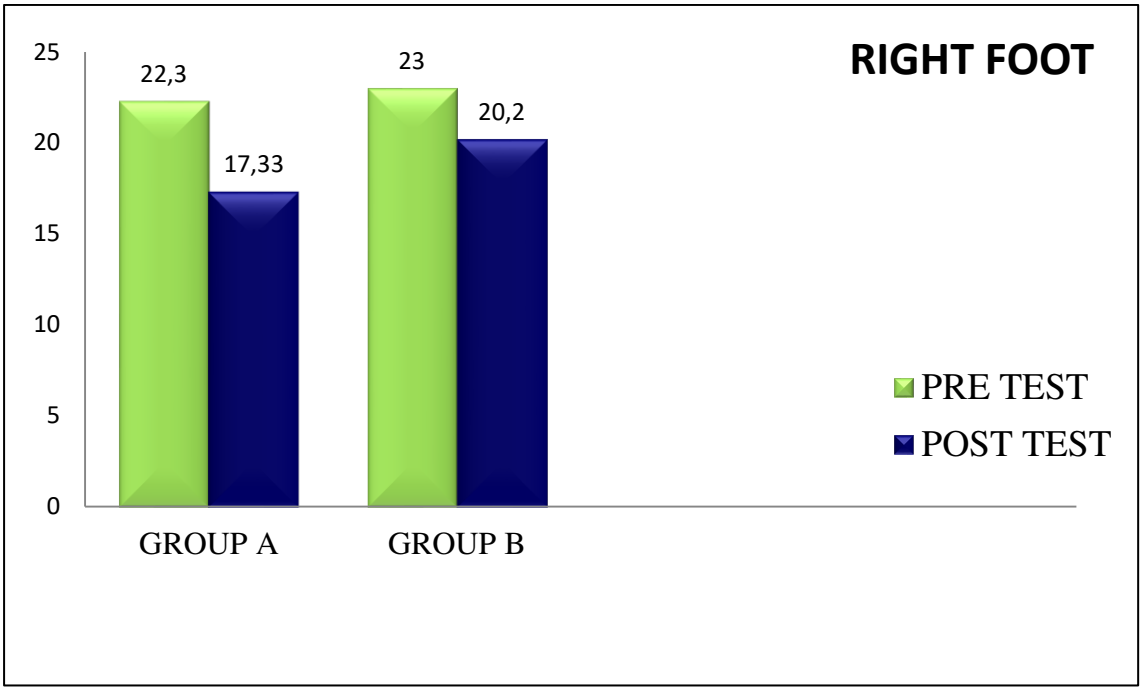


Graph 5.2: DYNAMIC BALANCE: GROUP A & GROUP B
Mean Value Changes in TUG test score for Both Group A (Experimental) and Group B (Control)

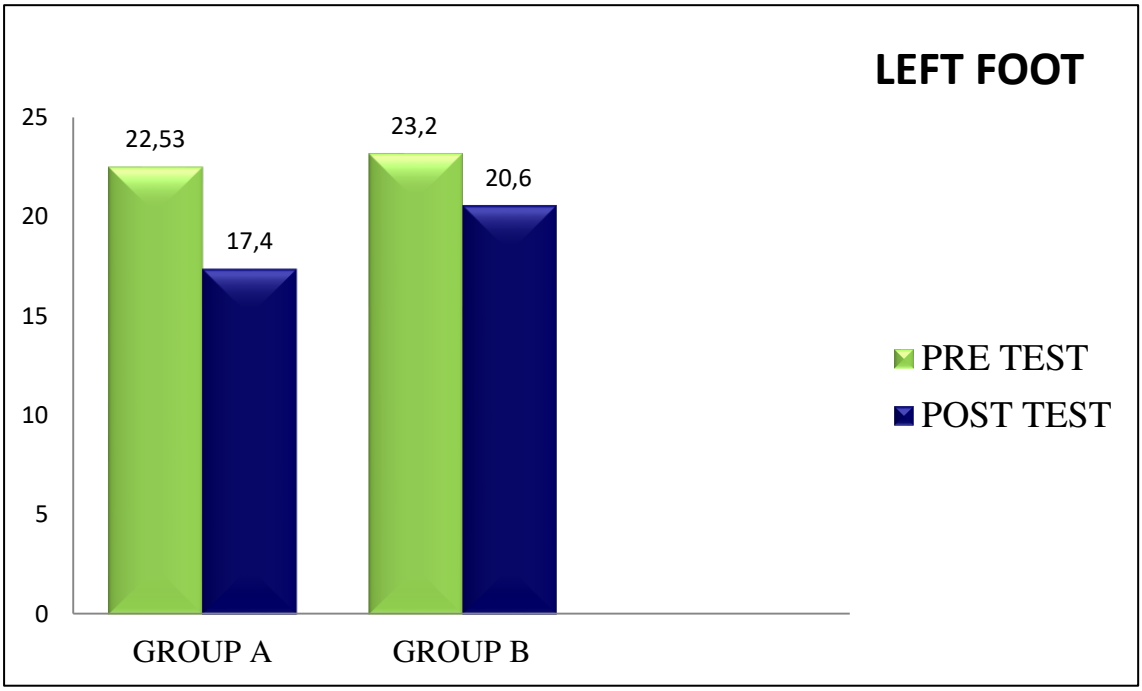


Graph 5.3: VIBRATORY PERCEPTION: GROUP A & GROUP B

Graph 5.3.1: Mean Value Changes In Vibratory Perception for Both Group A (Experimental) and Group B (Control) for Right Foot

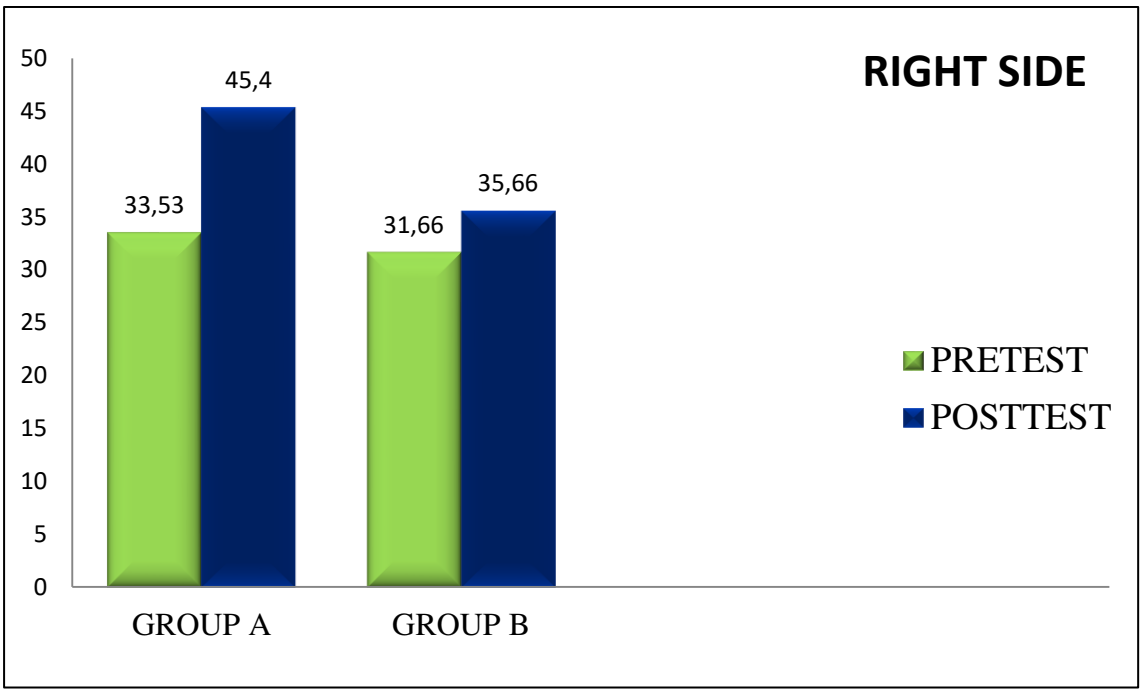


Graph 5.3.2: Mean Value Changes In Vibratory Perception for Both Group A (Experimental) and Group B (Control) for Left Foot

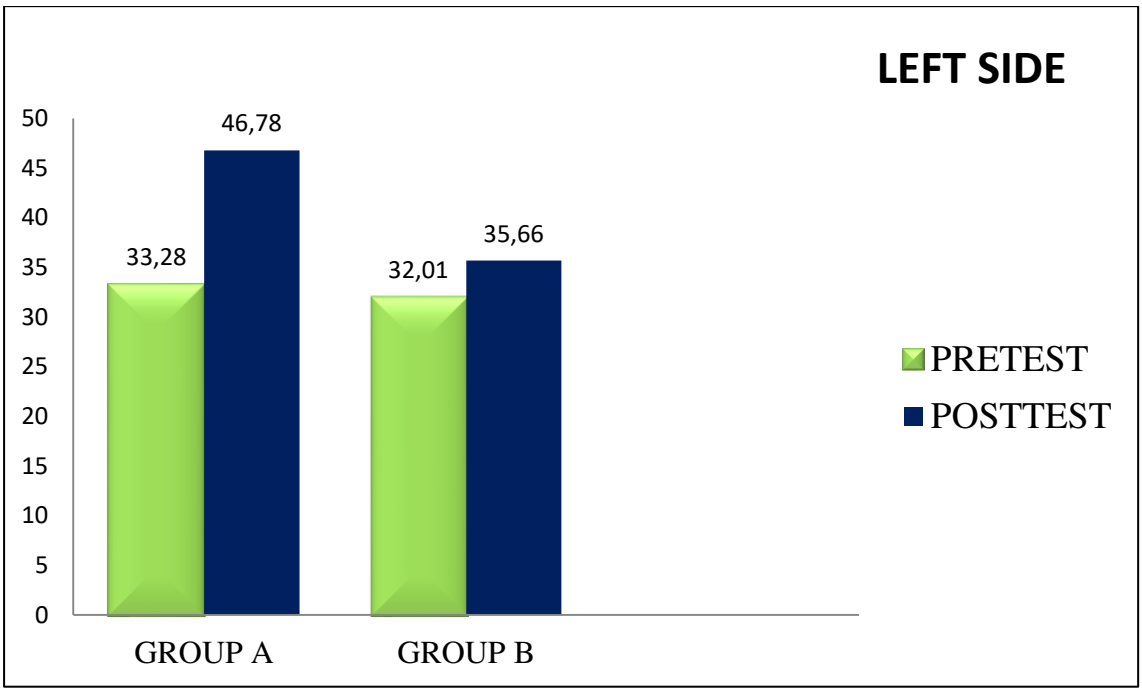


Graph 5.4: ACTIVE ANKLE RANGE OF MOTION: GROUP A & GROUP B

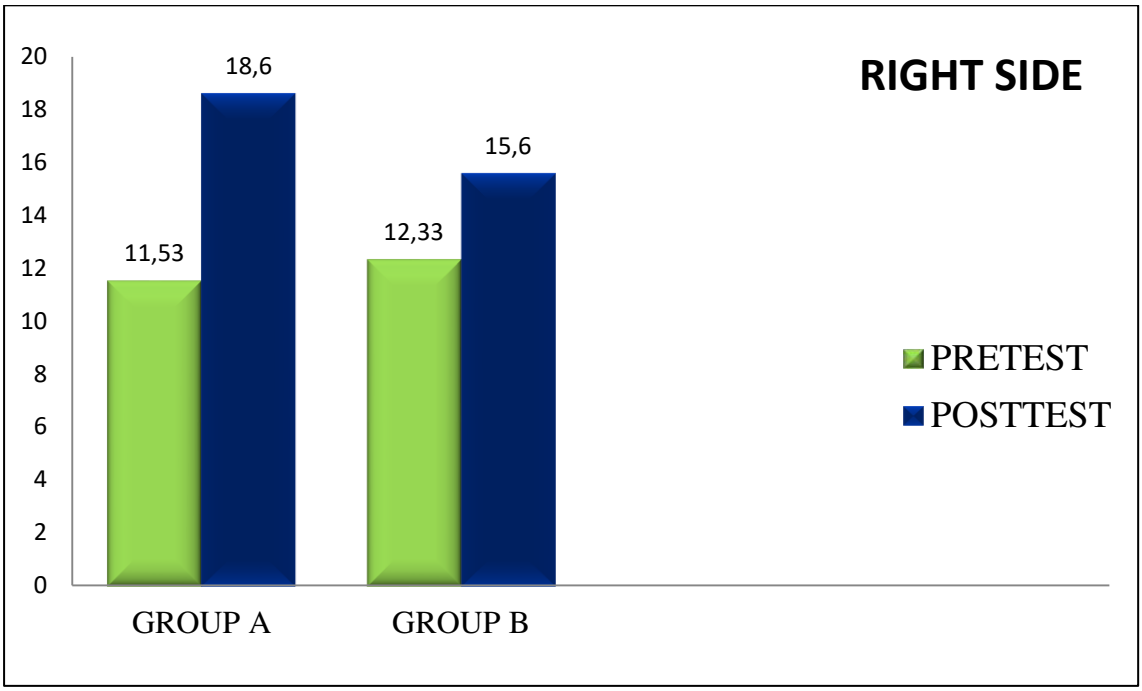
Graph 5.4.1: Mean Value Changes in Plantarflexion range for Both Group A (Experimental) and Group B (Control) for Right Foot



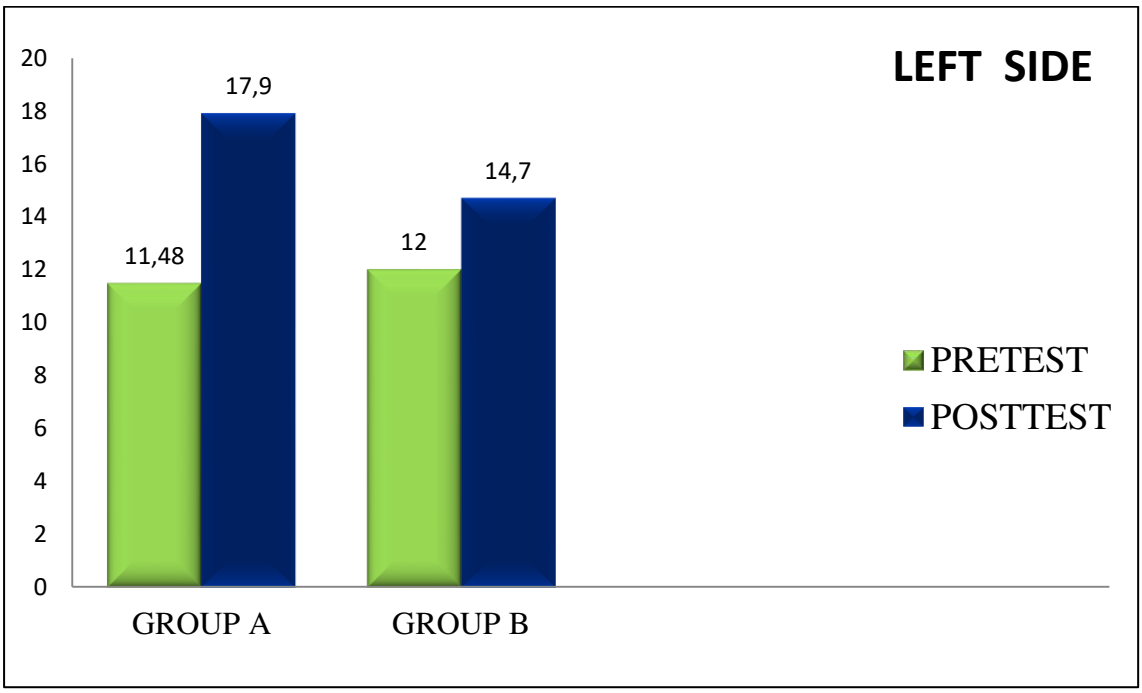
Graph 5.4.2: Mean Value Changes in Plantarflexion range for Both Group A (Experimental) and Group B (Control) for Left Foot



Graph 5.4.3: Mean Value Changes in Dorsiflexion range for Both Group A (Experimental) and Group B (Control) for Right side



Graph 5.4.4: Mean Value Changes in Dorsiflexion range for Both Group A (Experimental) and Group B (Control) for Left side



6. RESULTS AND DATA ANALYSIS

(GROUP A – Experimental Group GROUP B – Control Group)

6.1 PAIRED 't' TEST

6.1.1 GROUP A: EXPERIMENTAL GROUP

The pre-test and post-test values of group A in Vibratory Perception, Dynamic Balance, Static Balance and Active Ankle Range of Motion using biothesiometer, TUG Test, Sharpen Romberg Test and Goniometer were analysed using paired 't' test. For 14 degrees of freedom, at 5% level of significance, the table 't' value is 2.14 and the calculated 't' value is 12.07 in right foot, 16.74 in left foot for Vibratory Perception,27.8 for Dynamic Balance, 26.89 for Static Balance, 15.48 in right leg,15.49 in left leg (plantarflexion), 19.73 in right leg,19.75 in left leg (dorsiflexion) for Active Ankle Range of Motion. Since the calculated 't' value is more than the table 't' value, null hypotheses are rejected. Hence there is a significant improvement in balance, vibratory perception and active ankle range of motion of Group A**.**

6.1.2 GROUP B: CONTROL GROUP

The pre-test and post-test values of group B in Vibratory Perception, Dynamic Balance, Static Balance and Active Ankle Range of Motion using biothesiometer, TUG Test, Sharpen Romberg Test and Goniometer were analysed using paired 't' test. For 14 degrees of freedom, at 5% level of significance, the table 't' value is 2.14 and the calculated 't' value is 2.11 in right foot, 2.12 in left foot for Vibratory Perception,12.73 for Dynamic Balance, 10.15 for Static Balance, 7.25 in right leg,7.28 in left leg (plantarflexion), 9.73 in right leg,9.76 in left leg (dorsiflexion) for Active Ankle Range of Motion. Since the calculated 't' value is more than the table 't' value in Dynamic Balance, Static Balance and Active Ankle Range of Motion, null hypotheses are rejected. Hence there is a significant improvement in balance and active ankle range of motion of Group B. But in vibratory perception calculated 't' value is less than the table 't' value, so the null hypothesis is accepted. Hence there is no significant improvement in Vibratory Perception of Group B.

6.2 INDEPENDENT ‘t’ TEST

6.2.1 PRETEST VALUES OF GROUP A & GROUP B

Both groups pre-test values of Vibratory Perception, Dynamic Balance, Static Balance and Active Ankle Range of Motion using biothesiometer, TUG Test, Sharpen Romberg Test and Goniometer were analysed using independent ‘t’ test. For 28 degrees of freedom, at 5% level of significance, the table ‘t’ value is 2.04 and the calculated ‘t’ value is 0.93 in right foot, 0.92 in left foot for Vibratory Perception,0.32 for Dynamic Balance, 1.46 for Static Balance, 1.91 in right leg,1.90 in left leg (plantarflexion), 1.81 in right leg,1.82 in left leg (dorsiflexion) for Active Ankle Range of Motion. Since the calculated ‘t’ value is less than the table ‘t’ value, **there is no significant difference between the experimental and control group pre-test values**.

6.2.2 POSTTEST VALUES OF GROUP A & GROUP B

Both groups post-test values of Vibratory Perception, Dynamic Balance, Static Balance and Active Ankle Range of Motion using biothesiometer, TUG Test, Sharpen Romberg Test and Goniometer were analysed using independent ‘t’ test. For 28 degrees of freedom, at 5% level of significance, the table ‘t’ value is 2.04 and the calculated ‘t’ value is 4.48 in right foot, 4.52 in left foot for Vibratory Perception,8.81 for Dynamic Balance, 12.51 for Static Balance, 7.23 in right leg,7.25 in left leg (plantarflexion), 5.96 in right leg,5.99 in left leg (dorsiflexion) for Active Ankle Range of Motion. Since the calculated ‘t’ value is more than the table ‘t’ value, **there is a significant difference between the experimental and control group post-test values**.

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7. DISCUSSION

Diabetic peripheral neuropathy is a common long-term complication of diabetes, a major cause of morbidity and increased mortality[10]. Its clinical manifestations include painful neuropathic symptoms and insensitivity, impaired balance which increase the risk of fall and foot ulceration. Impaired balance, fear of fall and foot ulceration makes the patient inactive. Sedentary life style leads to increase the nerve damage day by day[8].

A set of training initiated as early as possible will help the patient to attain a significant functional improvement in balance and general fitness. The lower Extremity weight bearing training help to improve plantar skin perfusion, mobility, bone health, muscle strength, general fitness and improvement in the performance of mechanoreceptors lead to improve the proprioception and functional balance. Analysis of pre-test values using independent t test shows that homogeneity was maintained between subjects of both experimental and control group ($p>0.05$)

Post-test independent t test values identifies a statistical significant difference between the subjects of two groups ($p<0.05$) which demonstrate a change which have occurred by the effect of treatment and not just because of chance.

STATIC BALANCE

Sharpen Romberg test is used to assess static balance. Sharpened Romberg test score also have showed a statistically significant change with paired t test analysis ($p<0.05$) in both the groups. Experimental group had a much better improvement compared to that of control group. The difference in mean values between two groups has demonstrated a better improvement in experimental group than in control group.

Mechanoreceptors are sensory receptors that respond to mechanical pressure or distortion. Diabetic peripheral neuropathy affects the function of muscle spindles and the integrity of skin mechanoreceptors. These deficit leads to a decrease in the ability to use ankle synergy and perceive passive movements at the ankle.

S R Colberg et al (2015) demonstrated improvement in performance of mechanoreceptor cells that provide protective sensation in the feet after a set of exercise[39]. Improvement in the performance of mechanoreceptors leads to improve the proprioception and balance in diabetic peripheral neuropathy patients. Functional balance has improved in both the groups but based on other outcomes measures, type and intensity of the conventional exercise the quality of improvement in the control group is still doubtful.

DYNAMIC BALANCE

TUG test was used to check the dynamic balance. TUG test score shows a statistical significant difference in both experimental and control group in paired t test analysis ($p<0.05$) after 8 weeks of intervention. This is in contradiction to the changes that are seen in vibration perception. Both the groups had improvement after the treatment, but the experimental group demonstrated a more significant change (mean diff = -5.76) than that of control group (mean diff = -2.53).

Balance is a fundamental ability for humans, and its impairment dramatically reduces an individual's ability to perform activities essential to daily living. Impaired postural control, decreased sensation in the plantar surface of the feet, reduced ankle mobility, muscle strength has led to balance disturbances in diabetic peripheral neuropathy patients.

According to Shumway-Cook A the components of postural control includes musculoskeletal, internal representations, adaptive mechanisms, anticipatory mechanisms, sensory strategies, individual sensory systems and neuromuscular synergies[48]. Abeer El et al (2012) demonstrated that improvement in balance after doing a set of balance exercises[2]. Lower extremity weight bearing exercise help to improve the mobility, bone health, muscle strength, & general fitness in diabetic peripheral neuropathy. This in turn has led to an improvement balance which supports the study mentioned above.

VIBRATORY PERCEPTION

There is a significant improvement in the vibratory perception in experimental who received weight bearing exercise for 8 weeks. but the control group who receive the conventional training alone shows no statistical significance between the Pretest and Posttest values.

Malik and colleagues described that Diminished local blood flow can initiate oxidative stress and the release of factors that impede the normal passage of neurological signals in diabetic peripheral neuropathy patients which result insensate foot. An improvement in the vibratory perception after the intervention thus explains a significant improvement in plantar skin perfusion in response to exercise. These changes lead to improve both static and dynamic balance and also reduce the risk of foot ulceration

ACTIVE ANKLE RANGE OF MOTION

There is a significant improvement in active ankle plantarflexion and dorsiflexion range of motion of the both legs after the 8 weeks intervention. Experimental group who receive the set of weight bearing training had a much better improvement compared to that of control group who received the conventional training only. The difference in mean values between two groups has demonstrated a better improvement in experimental group than in control group.

Gretchen et al (2000) found that subjects with diabetes and peripheral neuropathy had decreased leg muscles peak torque compared with age-matched control groups[13]. Muller et al (2013) documented decreased ankle range of motion in this population due to increased plantar flexor stiffness and diminished peak torque which contribute to increased plantar pressure during gait cause foot ulceration[28].

This set of lower extremity weight bearing exercises improves the leg muscle strength and increase the length of plantar flexors. These changes lead the improvement in ankle plantarflexion and dorsiflexion range of motion in both legs.

8. CONCLUSION

The result of this study indicates that lower extremity weight bearing training along with conventional training improves the Functional Balance, Vibratory Perception and ankle mobility in Diabetic peripheral neuropathy patients.

9. LIMITATIONS AND SUGGESTIONS

9.1 LIMITATIONS

- This study was done with small number of samples
- Treatment duration is not enough to produce many effects
- Exercises were prescribed as home program, supervision was not provided hence the outcome was influenced by patients effort and motivation
- This simple measure for balance is not enough to measure the balance in these patients.
- These simple clinical test are not applicable for patients who are having difficulty in walking and standing
- Effect of aging is not taken into consideration
- The study was not single or double blinded

9.2 SUGGESTIONS

- A future study with large sample is recommended
- Other factors which influence the balance of patients can also be analysed in future research with lower extremity weight bearing exercise
- Further extension of research can be done using Doppler study to reinforce the conclusion reached at present
- Measures should be taken to exclude the effect of aging
- Can be compared with diabetic patients who don't have peripheral neuropathy
- A future study with Supervised training is recommended
- Two or three post-test measurements are suggested for further studies

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APPENDIX - I

INFORMED CONSENT FORM

I _____, consent the researcher for my voluntary participation in the study **"EFFECTIVENESS OF LOWER EXTREMITY WEIGHT BEARING TRAINING ALONG WITH THE CONVENTIONAL TRAINING TO IMPROVE BALANCE, VIBRATION PERCEPTION AND ANKLE MOBILITY IN DIABETIC PERIPHERAL NEUROPATHY PATIENTS"** The researcher has explained me the treatment approach in brief, the risk of participation and has answered the questions related to the research to my satisfaction.

SIGNATURE OF PARTICIPANT:

SIGNATURE OF RESEARCHER:

SIGNATURE OF WITNESS:

APPENDIX – II

ASSESSMENT PERFORMA

- Name:
- Age:
- Consulting Physician:
- Gender: M/F
- Hospital No:
- Date of Assessment:
- Phone number:
- Known diabetic for past ---------- years
- HbA1C: Date:
- Michigan Neuropathy Screening Instrument score: ---------/10
- The patient and caretaker has received and understood

  the exercises verbally as well as in the pamphlet provided : YES/NO

- Record sheet obtained: YES/NO

- **Sharpen Romberg Test Score** (in sec):

Pre-test Score	**Post-test score**

- **TUG Test Score** (in sec):

Pre-test Score	**Post-test score**

- **Vibratory Perception Score** (in W):

Pre-test Score	**Post-test score**

- **Active ankle ROM** :

Pre-test Score		**Post-test score**	
DF	PF	DF	PF

APPENDIX – III

MICHIGAN NEUROPATHY SCREENING INSTRUMENT

Physical Assessment (To be completed by health professional)

1. **Appearance of Feet**

RIGHT

Normal: ☐ 0 Yes ☐ 1 No

If no check all those apply:

Deformities ☐

Dry skin, callus ☐

Infection ☐

Fissure ☐

Other ☐

Specify: _____

2. **Ulceration** Absent ☐ 0 Present ☐ 1

3. **Ankle Reflexes** Present ☐ 0 Present/ Reinforcement ☐ 0.5 Absent ☐ 1

4. **Vibration**

Perception at great toe	Present	Decreased	Absent
	☐ 0	☐ 0.5	☐ 1

5. **Monofilament**

	Normal	Reduced	Absent
	☐ 0	☐ 0.5	☐ 1

1. **Appearance of Feet**

LEFT

Normal: ☐ 0 Yes ☐ 1 No

If no check all those apply:

Deformities	☐
Dry skin, callus	☐
Infection	☐
Fissure	☐
Other	☐

Specify: _____

2. **Ulceration**

Absent	Present
☐ 1	☐ 1

3. **Ankle Reflexes**

Present	Present/ Reinforcement	Absent
☐ 0	☐ 0.5	☐ 1

4. **Vibration**

Perception at great toe	Present	Decreased	Absent
	☐0	☐0.5	☐1

5. **Monofilament**

	Normal	Reduced	Absent
	☐ 0	☐ 0.5	☐ 1

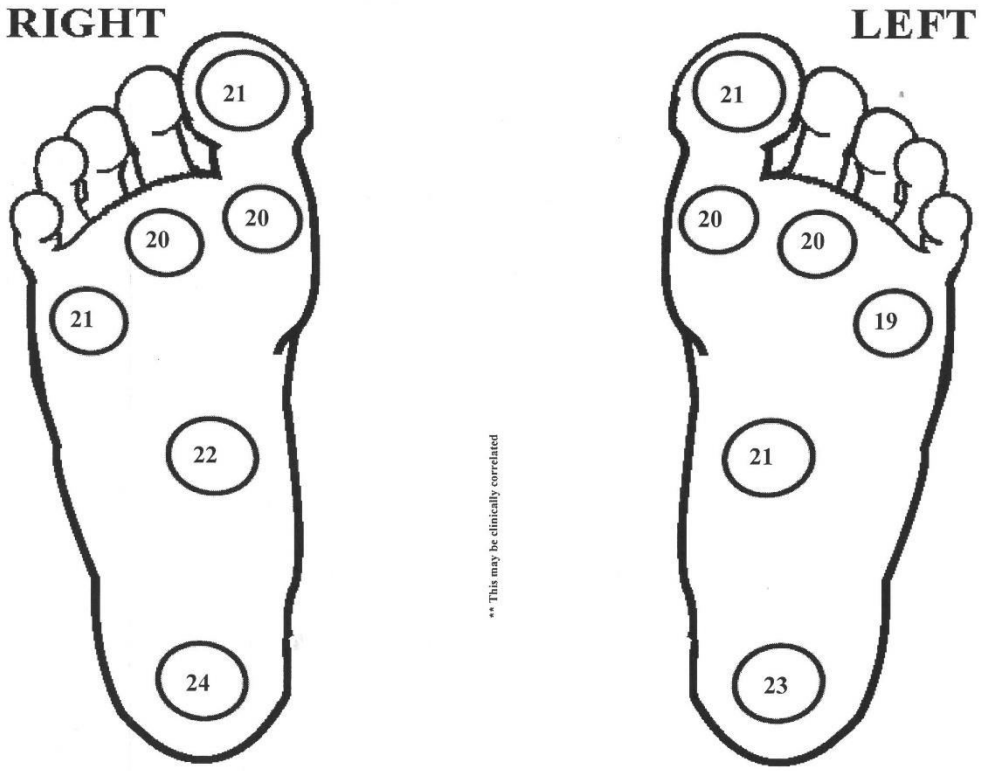
Nature: _____ Total Score:_____

APPENDIX VI

Kovai Medical Center and Hospital
Dept.of Physical medicine
FOOT CLINIC

Patient ID:	531515	**Refered By:**	Dr. Edmund MD Couto
Patient Name:	Sumathi.E	**Date & Time:**	27-Jan-2017 / 10:08:07 AM
Age:	55	**Gender:**	Female

BIOTHESIOMETRY STUDY



Average: 21 - Moderate Loss of Vibratory Perception** 21 - Moderate Loss of Vibratory Perception**

Remarks:

Consultant: Dr. Sivananam
Specialisation:

APPENDIX IV

Sharpened Romberg Test

PROCEDURE

- The applicant stand in heel to toe position, with their arms folded across chest and eyes closed
- Record Time the duration that they are able to maintain their balance
- The test ceases at 30 sec or loss of balance (excessive sway, loss of balance, stepping during test, opening eyes)
- If can hold for 30 sec in first trial other trials not needed
- Complete 3 trials if the applicant is unable to hold the position for 30 seconds in the first 2 trails
- Record the duration for each trial

Sharpened Romberg Testing Form

Name: _____

PRE Test

Date: _____

1) Total time:_____/30 sec
2) Total time:_____/30 sec
3) Total time:_____/30 sec MEAN SCORE: _____/30 sec

POST Test

Date: _____

1) Total time:_____/30 sec
2) Total time:_____/30 sec
3) Total time:_____/30 sec MEAN SCORE: _____/30 sec

APPENDIX – V

TIMED UP AND GO TEST

General Information

The patient should sit on a standard armchair, placing his/her back against the chair and resting his/her arms chair's arms. Any assistive device used for walking should be nearby.

Regular footwear and customary walking aids should be used.

The patient should walk to a line that is 3 meters (9.8 feet) away, turn around at the line, walk back to the chair, and sit down.

The test ends when the patient's buttocks touch the seat.

Patients should be instructed to use a comfortable and safe walking speed.

A stopwatch should be used to time the test (in seconds).

Set-up

Measure and mark a 3 meter (9.8 feet) walkway

Place a standard height chair (seat height 46cm, arm height 67cm) at the beginning of the walkway

Patient Instructions

Instruct the patient to sit on the chair and place his/her back against the chair and rest his/her arms chair's arms.

The upper extremities should not be on the assistive device (if used for walking), but it should be nearby.

Demonstrate the test to the patient.

When the patient is ready, say "Go"

The stopwatch should start when you say go, and should be stopped with the patient's buttocks touch the seat.

TIMED UP AND GO TESTING FORM

Name: _____

Assistive Device and/or Bracing Used: _____

PRE TEST

Date: _____

TUG Time: 1) _____ 2) _____ 3)_____

POST TEST

Date: _____

TUG Time: 1) _____ 2) _____ 3)_____

APPENDIX – VII

CONVENTIONAL TREATMENT

As a warm up [open chain ankle range of motion exercise] subject will be asked to write the alphabet in the air with each foot by moving ankle.

பயிற்சிக்கு தயாராக உங்களது ஒவ்வொரு காலாலும் ஆங்கில எழுத்துக்களை காற்றில் எழுதவேண்டும்.

1. DEEP BREATHING EXERCISE / **மூச்சு பயிற்சி**

- Patient should be in relaxed position either sitting or lying
- Take deep inspiration through nose and expire through mouth
- 10 repetitions in one set, do 3 sets

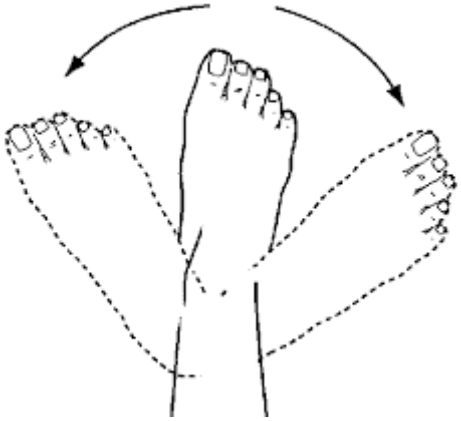
❖ நோயாளிகள் அமர்ந்தோ அல்லது படுத்தோ உடலை தளர்வான நிலையில் வைத்திருக்க வேண்டும்.

❖ ஆழமாக மூச்சை மூக்கின் வழியாக உள் இழுத்து வாயின் வழியாக வெளியிடவேண்டும்.

❖ 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

2. RANGE OF MOTION EXERCISE OF BILATERAL ANKLE **இரு கணுக்கால்கள் பயிற்சி**

Ankle dorsiflexion/plantarflexion



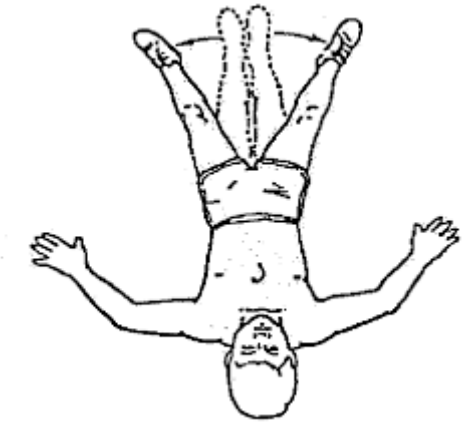
Ankle inversion/eversion

- Patient should be in relaxed position either sitting or lying
- Do bilateral ankle movements: plantar flexion, dorsiflexion, inversion, and eversion in pain free range of motion
- 10 repetitions in one set do 3 sets.
- நோயாளிகள் அமர்ந்தோ அல்லது படுத்தோ உடலை தளர்வான நிலையில் இருக்க வேண்டும்.
- கணுக்காலை நிலையாக வைத்து பாதத்தை மேலும் கீழுமாக அசைத்தல் மற்றும் பக்கவாட்டில் அசைத்தல்
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

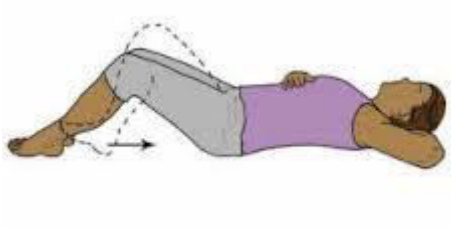
3. RANGE OF MOTION EXERCISE OF BILATERAL HIP AND KNEE

இருபக்க மூட்டு மற்றும் இடுப்பு இயக்கம் உடற்பயிற்சி

Hip flexion/extension



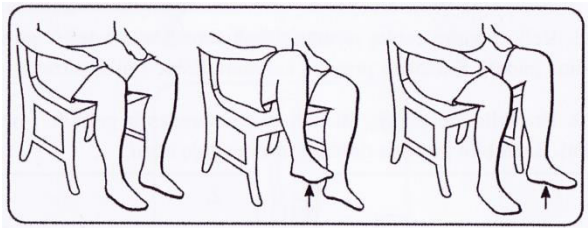
Hip abduction/adduction



Knee flexion/extension

- Patient should be in supine lying
- Do bilateral hip & knee movements: hip flexion/extension, abduction/adduction, external /internal rotations
- Knee flexion/ extension
- Do in pain free range of motion
- Each exercise 10 repetitions in one set do 3 set.
- முதுகுதண்டு தரையில் படியும்படி படுத்துக்கொள்ள வேண்டும்.
- ஒவ்வொரு காலையும் மேல்நோக்கி இரு கைகளின் உதவியுடன் இயன்றவரை மடித்தல், நீட்டுதல்
- கால்களை பக்கவாட்டில் விரித்தல், சேர்த்தல்.
- படுத்திருக்கும் நிலையிலேயே கால்களை உட்புறமாக மடித்தல், நீட்டுதல்.
- இந்த பயிற்சிகளை வலி இல்லாத அளவிற்கு செய்தால் போதுமானது.
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

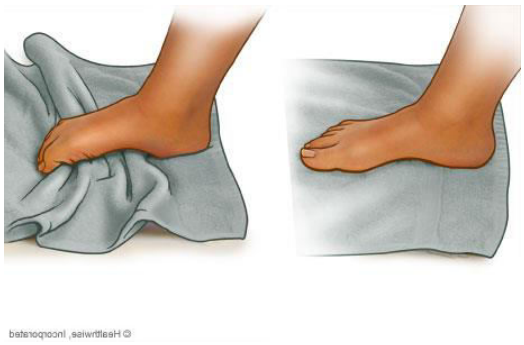
4. SPOT MARCHING **ஸ்பாட் அணிவகுப்பு பயிற்சி**



- Patient should be in relaxed sitting position
- Do 50 counts
- நோயாளிகள் நாற்கலியில் அமர்ந்து உடலை தளர்வான நிலையில் இருத்தல்.
- அமர்ந்திருக்கும் நிலையிலேயே ஒவ்வொரு காலையும் மேலும் கீழுமாக 50 முறை ஏற்றி இறக்கவேண்டும்

5. GRASPING THE TOWEL WITH TOES IN THE FLOOR **தரையில்**

விரித்திருக்கும் துண்டை கால் விரல்களால் சுருட்டி விரிக்கும் பயிற்சி



- 10 repetitions in one set do 3 sets
- Patient should be in sitting or standing posture
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.
- இப்பயிற்சியின் போது நோயாளிகள் அமர்ந்த அல்லது நின்ற நிலையில் இருக்கவேண்டும்

EXPERIMENTAL GROUP

Warm up [open chain ankle rom exercises] subject wrote the alphabet in the air with each foot by moving ankle

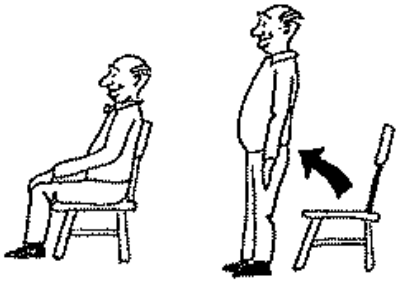
பயிற்சிக்கு தயாராக உங்களது ஒவ்வொரு கால்களாலும் ஆங்கில எழுத்துக்களை காற்றில் எழுதவேண்டும்.

LEVEL 1 [1-2 WEEKS] **நிலை 1 (1-2 வாரங்கள்)**

- Do the same conventional treatment

மேற்கண்ட வழக்கமான பயிற்சிகளையும் சேர்த்து,

1. SIT-TO-STAND ACTIVITY / அமர்ந்து எழும் பயிற்சி



- Use back supported chair
- Patient feet kept shoulder width apart
- 10 repetitions in one set do 3 set
- இந்த பயிற்சிக்கு சாயும் நாற்காலியை பயன்படுத்தவும்.
- எழும்போதும் அமரும்போதும் பாதங்களை நிலையாக வைத்திருக்கவேண்டும்
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

2. WEIGHT SHIFTING

உடல் எடையை இரு கால்களுக்கும் மாற்றும் பயிற்சி

- Stand with wide base of support
- Shift the weight in to both legs do not take off the legs from floor
- 10 repetitions in one set, do 3 set
- கால்களின் இடையே போதிய அளவு இடைவெளி விட்டு நிற்கவேண்டும்.
- கால்களை தரையில் நிலையாக வைத்துக்கொண்டு இடுப்பை பக்கவாட்டில் அசைத்து இரு கால்களும் உடல் எடையை தங்குமாறு மாற்றிமாற்றி நிற்கவேண்டும்.
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

2. SQUATTING / உட்கார முயன்று எழும் பயிற்சி

- With both hand support
- Patient feet kept shoulder width apart
- 5 seconds hold the squatting position then get up
- 10 repetitions in one set, do 3 sets
- மேசை அல்லது நாற்கலியின் மீது இரு கைகளுக்கும் ஆதரவாக பிடித்து நிற்க வேண்டும்
- பாதம் மற்றும் தோள்பட்டை ஒரே நேர்கோட்டில் வைத்து முழங்கால்களை சற்றே மடக்கி நிற்க வேண்டும்.
- 5 வினாடிகள் இதே நிலையில் நிற்கவேண்டும்.
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்

3. BIPEDAL HEEL RAISE

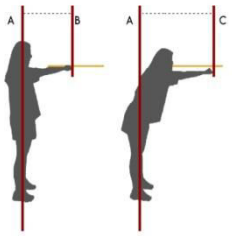
இரு கால்களையும் தரையில் அழுத்தி குதிங்காலை உயர்த்தி நிற்கும் பயிற்சி

- With hand support
- 10 repetitions in one set do, 3 sets
- மேசை அல்லது நாற்கலியின் மீது இரு கைகளுக்கும் ஆதரவாக பிடித்து நிற்க வேண்டும்

- இரு கால் விரலையும் தரையில் அழுத்தி குதிங்காலை உயர்த்தி 5 வினாடிகள் நிற்கவேண்டும்
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

4. FUNCTIONAL REACHING

உடல் இயக்க ஆய்வு பயிற்சி



- Anteriorly& sideways lean for touching targets[45 cm first gradually increase the distance ,1meter and 1.5 meter]
- 10 repetitions in one set, do 3 sets
- சாதாரணமாக நின்ற நிலையில் முன் பக்கமாக ஒரு இலக்கை தொடவேண்டும். (முதல்முறை 45cm இடைவெளியும் இரண்டாம் முறை 1மீட்டர் இடைவெளியும் 1.5 மீட்டர் இடைவெளி வைத்தும் இலக்கை தொட வேண்டும்).
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

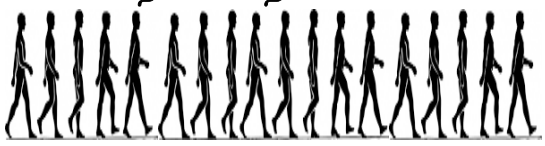
5. UNIPEDAL/ONE LEG STANDING

ஒற்றை காலில் நிற்கும் பயிற்சி

- With both hand support
- Ask the patient to stand at least 10 seconds initially
- 10 repetitions in one set, do 3 sets
- மேசை அல்லது நாற்கலியின் மீது இரு கைகளுக்கும் ஆதரவாக பிடித்து ஒற்றை காலில் மாறி மாறி நிற்க வேண்டும்
- 10 வினாடிகள் இதே நிலையில் நிற்கவேண்டும்.
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

6. WALKING

நடை பயிற்சி



- 5 minutes warm up
- 5 minutes walking
- Gradually increase the speed of walking
- 5 minutes cool down gradually decrease the speed of walking
- Teach the patients to check the pulse rate if pulse rate increases more than the normal level stop walking and advice to take rest.

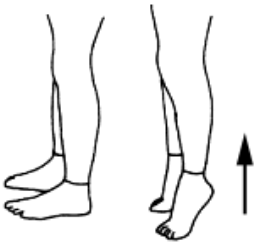
- 5 நிமிடம் நடை பயிற்சிக்கு தயாராகுதல்
- முதல் 5 நிமிடம் மிதமான வேகத்தில் நடக்க வேண்டும்
- பின்பு மெதுவாக நடையின் வேகத்தை அதிகரிக்க வேண்டும்.
- அடுத்த 5 நிமிடங்கள் மெதுவாக நடையின் வேகத்தை குறைத்துக்கொள்ள வேண்டும்.
- நோயாளிகளுக்கு இரத்த அழுத்தம் அவ்வப்போது பரிசோதிக்கவேண்டும். இரத்த அழுத்தம் இயல்பை விட அதிகரிக்கும்போது நடை பயிற்சியை நிறுத்தி ஓய்வெடுக்க வேண்டும்.

LEVEL 2[3-4 WEEKS]

நிலை 2 (3 முதல் 4 வாரங்கள்)

1. BIPEDAL HEEL RAISE

இரு கால்களையும் தரையில் அழுத்தி குதிங்காலை உயர்த்தி நிற்கும் பயிற்சி



HEEL RAISES

- With one hand support
- 10 repetitions in one set do 3 sets
- மேசை அல்லது நாற்கலியின் மீது ஒரு கையை மட்டும் ஆதரவாக பிடித்து நிற்க வேண்டும்
- இரு கால் விரலையும் தரையில் அழுத்தி குதிங்காலை உயர்த்தி 15 வினாடிகள் நிற்கவேண்டும்
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

2. TOE RAISE

நின்ற நிலையில் முன்னங்கால்களை உயர்த்தும் பயிற்சி

- With one hand support
- 10 repetitions in one set do 3 sets
- மேசை அல்லது நாற்கலியின் மீது ஒரு கையை மட்டும் ஆதரவாக பிடித்து நிற்க வேண்டும்
- இரு பின்பாதங்களை தரையில் அழுத்தி முன் பாதங்களை 15 வினாடிகள் உயர்த்துதல்.
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

3. SQUATTING

உட்கார முயன்று எழுந்து நிற்கும் பயிற்சி

- With one hand support
- Patient feet kept shoulder width apart
- 15 seconds hold the squatting position then get up
- 10 repetitions in one set do 3 sets
- மேசை அல்லது நாற்கலியின் மீது ஒரு கையை மட்டும் ஆதரவாக பிடித்து நிற்க வேண்டும்
- பாதம் மற்றும் தோள்பட்டை ஒரே நேர்கோட்டில் வைத்து முழங்கால்களை சற்றே மடக்கி நிற்க வேண்டும்.
- 15 வினாடிகள் இதே நிலையில் நிற்கவேண்டும்.
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

4. ONE LEG STANDING/UNIPEDAL STANDING

ஒற்றை காலில் நிற்கும் பயிற்சி

- With one hand support if necessary
- Ask the patient to stand in one leg at least for 15 seconds
- 10 repetitions in one set do 3 sets
- தேவை ஏற்பட்டால் மேசை அல்லது நாற்கலியின் மீது ஒரு கையை மட்டும் ஆதரவாக பிடித்து ஒற்றை காலில் மாறி மாறி நிற்க வேண்டும்
- 15 வினாடிகள் இதே நிலையில் நிற்கவேண்டும்.
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

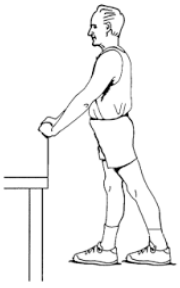
5. UNIPEDAL STAND OVER PILLOW

தலையணையின் மீது ஒற்றை காலில் நிற்கும் பயிற்சி

- With hand support
- Ask the patient to stand at least 10 sec
- 10 repetitions in one set do 3 sets
- மேசை அல்லது நாற்கலியின் மீது இரு கைகளுக்கும் ஆதரவாக பிடித்து தலையணையின் மீது ஒற்றை காலில் மாறி மாறி நிற்க வேண்டும்
- 10 வினாடிகள் இதே நிலையில் நிற்கவேண்டும்.
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

6. TANDEM STANDING

அடி பிரதசஷ்ணம்

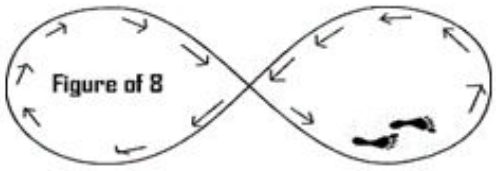


- with hand support if necessary
- Ask the patient to stand at least 10 seconds

- 10 repetitions in one set, do 3 sets
- தேவை ஏற்பட்டால் மேசை அல்லது நாற்கலியின் மீது இரு கைகளுக்கும் ஆதரவாக பிடித்து கொண்டு இரு கால்களையும் ஒன்றன் பின் ஒன்றாக ஒரே நேர்கோட்டில் வைத்தல்
- 10 வினாடிகள் இதே நிலையில் நிற்கவேண்டும்.
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்

7. WALKING IN FIGURE OF EIGHT

எட்டு வடிவத்தில் நடக்கும் பயிற்சி



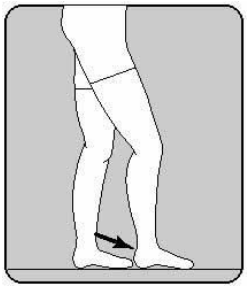
- Walk with one hand support
- 5 repetitions in one set do 3 sets
- தரையில் 8 போன்ற வடிவமைத்து அந்த வடிவத்தின்மீது நடத்தல்.
- 1 முறைக்கு 5 தடவை வீதம் 3 முறை செய்ய வேண்டும்

LEVEL 3 [5-6 WEEKS]

நிலை 3 (5-6 வாரங்கள்)

1. TANDEM STANDING

அடி பிரதக்ஷணம்



- Without support

- Ask the patient to stand at least 15 seconds
- 10 repetitions in one set do 3 sets
- எவ்வித ஆதரவுமின்றி இரு கால்களையும் முன்னும் பின்னுமாக ஒரே நேர்கோட்டில் வைத்தல்
- 15 வினாடிகள் இதே நிலையில் நிற்கவேண்டும்.
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்

2. UNIPEDAL STAND OVER PILLOW

தலையணையின் மீது ஒற்றை காலில் நிற்கும் பயிற்சி

- Without hand support
- Ask the patient to stand at least 15 sec
- 10 repetitions in one set do 3 sets
- எவ்வித ஆதரவுமின்றி தலையணையின் மீது ஒற்றை காலில் மாறி மாறி நிற்க வேண்டும்
- 15 வினாடிகள் இதே நிலையில் நிற்கவேண்டும்.
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

3. TOE RAISE

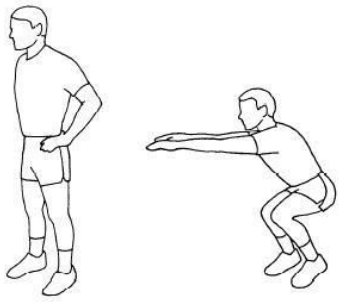
நின்ற நிலையில் முன்னங்கால்களை உயர்த்தும் பயிற்சி

- Without hand support
- 10 repetitions in one set, do 3 sets

- எவ்வித ஆதரவுமின்றி இரு பின்பாதங்களை தரையில் அழுத்தி முன் பாதங்களை 15 வினாடிகள் உயர்த்துதல்.
  1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

4. SQUATTING

உட்கார முயன்று எழும் பயிற்சி



- Without support
- Patient feet kept shoulder width apart
- 20 seconds hold the squatting position then get up
- 10 repetitions in one set, do 3 sets
- எவ்வித ஆதரவுமின்றி பாதம் மற்றும் தோள்பட்டை ஒரே நேர்கோட்டில் வைத்து முழங்கால்களை சற்றே மடக்கி நிற்க வேண்டும்.
- 20 வினாடிகள் இதே நிலையில் நிற்கவேண்டும்.
- 1 முறைக்கு 10 தடவை வீதம் 3 முறை செய்ய வேண்டும்.

5. TANDEM WALKING

அடி பிரதசஷ்ணம்

- With one hand support

- Walk for 3 meter
- Do twice
- சுவற்றை ஆதரவாக ஒரு கையில் பிடித்து கொண்டு இரு கால்களையும் ஒன்றன் பின் ஒன்றாக ஒரே நேர்கோட்டில் வைத்து 3 மீட்டர் வரை நடத்தல்
- இரண்டு முறை இப்பயிற்சியை செய்ய வேண்டும்

6. TOE WALK

இரு கால்களையும் தரையில் அழுத்தி குதிங்காலை உயர்த்தி நடக்கும் பயிற்சி

- With hand support
- Walk for 3 meter
- Do twice
- மேசை அல்லது நாற்கலியின் மீது இரு கைகளுக்கும் ஆதரவாக பிடித்து நடக்க வேண்டும் இரு கால் விரலையும் தரையில் அழுத்தி குதிங்காலை உயர்த்தி 3 மீட்டர் வரை நடக்க வேண்டும்
- இரண்டு முறை இப்பயிற்சியை செய்ய வேண்டும்

7. BACKWARD WALKING

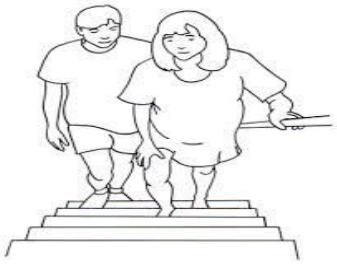
பின்னோக்கி நடக்கும் பயிற்சி

- With one hand support
- Walk 3 meter
- Do twice

- சுவற்றை ஆதரவாக ஒரு கையில் பிடித்து கொண்டு இரு கால்களையும் ஒன்றன் பின் ஒன்றாக ஒரே நேர்கோட்டில் வைத்து பின்னோக்கி 3 மீட்டர் வரை நடத்தல்
- இரண்டு முறை இப்பயிற்சியை செய்ய வேண்டும்

8. STAIR CLIMBING

மாடிப்படி ஏறும் பயிற்சி



- With one hand support
- 10 steps up & down
- Do twice
- கைப்பிடி சுவற்றை ஆதரவாக ஒரு கையில் பிடித்து கொண்டு 10 மாடிப்படிகள் ஏறி இறங்க வேண்டும்
- இரண்டு முறை இப்பயிற்சியை செய்ய வேண்டும்

LEVEL 4 [7-8 WEEKS]

நிலை 4 (7-8 வாரங்கள்)

1. STANDING ARM /LEG MARCH

நின்ற நிலை நடைப்பயிற்சி

- Do 10 counts in one set do 3 set

  நின்ற இடத்திலேயே நடக்க வேண்டும் 30 முறை

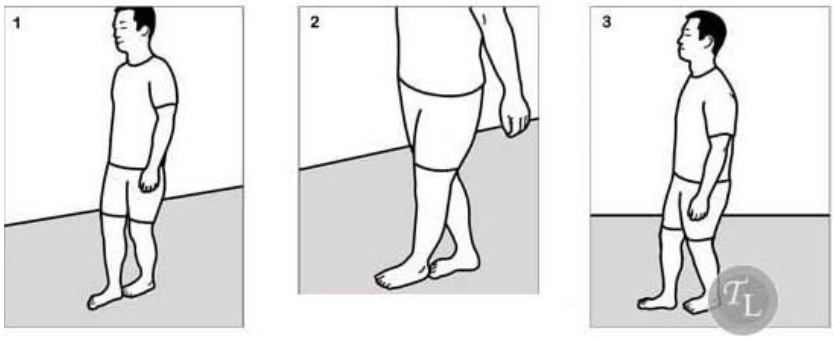
2. STEP SIDEWAYS

பக்கவாட்டில் நடைப்பயிற்சி

- Walk for 3 meters
- Without hand support
- Do both side
- Do twice
- சுவற்றை ஆதரவாக ஒரு கையில் பிடித்து கொண்டு பக்கவாட்டில் இடதுபுறமும் வலதுபுறமும் 3 மீட்டர் வரை நடத்தல்
- இரண்டு முறை இப்பயிற்சியை செய்ய வேண்டும்

3. TANDEM WALKING

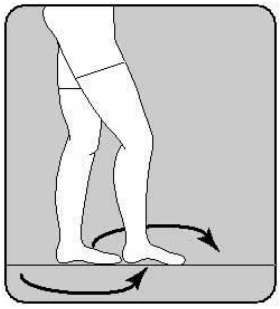
அடி பிரதசஷ்ணம்



- Without hand support
- Walk for 3 meter
- Do twice
- எவ்வித ஆதரவுமின்றி இரு கால்களையும் ஒன்றன் பின் ஒன்றாக ஒரே நேர்கோட்டில் வைத்து 3 மீட்டர் வரை நடத்தல்
- இரண்டு முறை இப்பயிற்சியை செய்ய வேண்டும்

4. CROSS OVER WALK

கால்களை வளைத்து நடக்கும் பயிற்சி



- Walk for 3 meters
- Do twice
- பக்கவாட்டில் கால்களை சற்று அகட்டி முன்னோக்கி 3 மீட்டர் வரை நடத்தல்
- இரண்டு முறை இப்பயிற்சியை செய்ய வேண்டும்

5. TOE WALK

இரு கால்களையும் தரையில் அழுத்தி குதிங்காலை உயர்த்தி நடக்கும் பயிற்சி

- Without hand support
- Walk for 3 meter
- Do twice
- எவ்வித ஆதரவுமின்றி இரு கால் விரலையும் தரையில் அழுத்தி குதிங்காலை உயர்த்தி 3 மீட்டர் வரை நடக்க வேண்டும்
- இரண்டு முறை இப்பயிற்சியை செய்ய வேண்டும்

6. BACKWARD WALKING

பின்னோக்கி நடக்கும் பயிற்சி

- Without support
- Walk for 3 meters
- Do twice
- எவ்வித ஆதரவுமின்றி இரு கால்களையும் ஒன்றன் பின் ஒன்றாக ஒரே நேர்கோட்டில் வைத்து பின்னோக்கி 3 மீட்டர் வரை நடத்தல்
- இரண்டு முறை இப்பயிற்சியை செய்ய வேண்டும்

7. STAIR CLIMBING

மாடிப்படி ஏறும் பயிற்சி

- Without hand support
- 20 steps up and down
- Do twice
- எவ்வித ஆதரவுமின்றி 20 மாடிப்படிகள் ஏறி இறங்க வேண்டும்
- இரண்டு முறை இப்பயிற்சியை செய்ய வேண்டும்

APPENDIX – VIII

WORK SHEET

Patient Name: Age:

Op Number: Training starting date:

Days weeks	MONDAY	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	TOTAL DAYS
1ST Week								
2nd Week								
3rd Week								
4th Week								
5th WEEK								
6th Week								
7th Week								
8th Week								