EFFECT OF DUAL TASK TRAINING AND SINGLE TASK TRAINING IN IMPROVING BALANCE AND DUAL TASK PERFORMANCE OF INDIVIDUALS WITH DIABETIC NEUROPATHY

AN EXPERIMENTAL STUDY

Dissertation submitted to the Tamilnadu Dr. M.G.R. Medical University towards partial fulfillment of the requirements of **MASTER OF PHYSIOTHERAPY (Advanced PT in Neurology)** Degree Programme.

KMCH COLLEGE OF PHYSIOTHERAPY

(A unit of Kovai Medical Centre Research and Educational Trust)

Post Box No. 3209, Avanashi Road,

Coimbatore – 641 014.

2010-2012

CERTIFICATE

This is to certify that the research work entitled "**EFFECT OF DUAL TASK TRAINING AND SINGLE TASK TRAINING IN IMPROVING BALANCE AND DUAL TASK PERFORMANCE OF INDIVIDUALS WITH DIABETIC PERIPHERAL NEUROPATHY.**" wascarried out by the candidate bearing the **Register No: 27101608**, KMCH College of Physiotherapy, towards partial fulfillment of the requirements of the Master of Physiotherapy (MPT) of the Tamil Nadu Dr. M. G. R. Medical University, Chennai - 32.

PROJECT GUIDE

Mr. K. SENTHIL KUMAR, M.P.T(Neuro)

Professor,

KMCH College of Physiotherapy,

Coimbatore - 641014.

PRINCIPAL

Dr. EDMUND M.D'COUTO

MBBS., Dip. Phy.Med.&Rehab.,

KMCH College of Physiotherapy,

Coimbatore - 641014.

INTERNAL EXAMINER

EXTERNAL EXAMINER

Project Evaluated on:

ACKNOWLEDGEMENT

ACKNOWLEDGEMENT

In this juncture, I express my heartfelt gratitude to all those who made this possible. I am very happy to express my first, sincere and heart full thanks to **'MY LORD GOD ALMIGHTY'** who showed his blessing on me to complete this project work in an efficient manner.

I wish to express my immense thanks to **My Beloved parents and brothers** for their love, affection, encouragement and support without which I would not have accomplished this great feat.

I would like to acknowledge my immense depth of gratitude towards **Chairman, Dr.Nalla G. Palaniswami,** Kovai Medical Centre and Hospital, for his guidance and allowing me to use the facilities of the department for this study.

I thank our **Trustee Dr.Thavamani D. Palaniswamy**, for her valuable guidance in fulfilment of this task.

My heartfelt thanks **to Dr. Edmund Mark D'Couto, MBBS.,D.Phys. Med.,** Principal, KMCH College of Physiotherapy for his advice, interest and guidance imparted to me for the proper completion of this study.

I forward my heartfelt gratitude towards **Mrs. A. P. Kalpana M.P.T.,** Vice Principal, KMCH college of Physiotherapy for her support throughout this study.

I sincerely thank my project guide **Mr. K. Senthil Kumar, M.P.T.**, Professor for his valuable suggestion, outstanding commitment, patience and concern at every part of this study.

I express my deep sense of gratitude and heartfelt thanks to my Class in-charge **Mrs. A. Brammatha M.P.T.,** for her whole hearted assistance and support throughout the project.

I would like to thank the faculty members **Mr. K. VenuGopal,** Professor in Research & Bio Statistics for reminding me that statistics is simple.

I wish to record my gratitude to **Mr. S. Sivakumar M.P.T., Mr. K. ShyamSundar M.P.T., Mr. U. Nambiraja M.P.T., Mrs. R. Uthra Devi M.P.T., Mr. David V. Samuel M.P.T.,** for their support.

I wish to express my sincere thanks to **Mr. S. Damodaran** and his **Colleagues**, for their co-operation and patience in providing reference material which was of immense help.

I would like **Mrs.Kaleeswari, (KMCH)** for her valuable contribution in enhancing my knowledge.

I express my hearty thanks to all my subjects for their active participation and co-operation.

My special thanks to my **classmates**who helped me in all the aspects during this course of study.

CONTENTS

CONTENTS

ABSTRACT

ABSTRACT

OBJECTIVE: Balance impairment is one of the major problems in individuals with diabetic peripheral neuropathy as a result of loss of sensory feedback from the periphery. Concentrating on cognitive aspect of balance which involvesattentional capacity can improve the balance and daily task performance. The aim of this study is to compare the effects of dual task training and single task training in improving balance and dual task performance of individuals with diabetic peripheral neuropathy. **STUDY DESIGN:** Two groups Pre test – Post test experimental study design. **PARTICIPANTS:** Twenty individuals with diabetic peripheral neuropathy of both the sexes who met the inclusion criteria were selected and randomly assigned into two groups, dual task training group and single task training group each contain ten subjects. **INTERVENTIONS:** single task training group treated with standing and walking balance exercises and dual task training group treated with standing and walking balance exercises in addition to cognitive task that is counting numbers in backwards by 2s done concurrently and these exercises done for thirty minutes a day five days per week for four weeks. **OUTCOME MEASURES:** Balance is measured by sharpen Romberg test (eyes closed) and single leg stance test (eyes opened and eyes closed, right leg and left leg) and dual task performance is measured by timed up and go test-dual task.**RESULTS:** At baseline subjects in both groups were closely similar. After the intervention both groups showed statistically significant differences on sharpen Romberg test, single leg stance test and timed up and go test. By comparing the mean value and percentage of improvement, dual task training group showed significant improvement than the single task group in both outcome measurements. **CONCLUSION:** This study revealed that there is significant improvement of dual task training group in improving balance and dual task performance.

INTRODUCTION

1. INTRODUCTION

Diabetes is a chronic disease, which occurs when the pancreas does not produce enough insulin, or when the body cannot effectively use the insulin it produces. This leads to an increased concentration of glucose in the blood (hyperglycemia)-WHO.

Type 1 diabetes (previously known as insulin-dependent) is characterized by a lack of insulin production, Type 2 diabetes (previously known as non-insulin-dependent) is caused by the body's ineffective use of insulin. It often results from excess body weight and physical inactivity and Gestational diabetes is hyperglycemia that is first recognized during pregnancy-WHO.

WHO estimates that more than 346 million people worldwide have diabetes. This number is likely to more than double by 2030 without intervention. Almost 80% of diabetes deaths occur in middle- and low-income countries.

The global prevalence of diabetes in adults (aged 20–79 years) was 6.4%, affecting 285 million adults, in 2010, and will increase to 7.7% affecting 439 million adults by 2030. Between 2010 and 2030, there will be a 69% increase in numbers of adult patients with diabetes in developing countries and a 20% increase in developed countries[34].

Type 2 diabetes is one of the growing public health problems in both developed and developing countries. It is estimated that the number of patients with diabetes in the world will double in coming years, from 171 million in 2000 to 366 million in 2030[19].

When compared to other countries, the prevalence is high in India because of onset of diabetes in young age and genetic factors[23].

WHO report reveals that India has the largest number of diabetic patients[15].

In the year 2002, the prevalence of risk factors for neuropathy in south India was studied by usingBiothesiometry the report noted that the prevalence is 19.1%, age and duration of disease is the main risk factor for neuropathy[5].

Diabetic neuropathy has been defined as presence of signs and symptoms of peripheral nerve dysfunction in diabetics after exclusion of other causes, which may range from hereditary, traumatic, compressive, metabolic, toxic, nutritional, infectious, immune mediated,neoplastic, and secondary to other systemic illnesses[6].

The classification of diabetic neuropathy is done with clinical manifestations (symmetrical, focal or multifocal, or painful, paralytic and ataxic), type of fibers affected (motor, sensory, autonomic), or painful or non-painful. Sensory-motor neuropathy is the commonest presentation of peripheral neuropathy[20].

It presents as distal, symmetrical sensory alterations that begin in the feet and ascend into the legs and hands with diminished ankle reflexes. Peripheral nerve damage affects approximately 25% of people who have had diabetes for 10 years and 50% of those who have had the condition for 20 years[30]. Symptoms are in variable extremes, from severely painful symptoms at one extreme to the completely painless variety, which may present with an insensitive foot ulcer at the other extreme.

The neuropathic symptoms are divided into positive or negative. The negative symptom includes numbness in the lower limbs and the positive symptoms are burning pain, altered and uncomfortable temperature perception, paraesthesia, shooting, stabbing pain, hyperaesthesia and allodynia[6].

In advanced stages of the disease, motor loss is obviously seen, till then it will be a minor or sub-clinical manifestation. The severity of the disease is related to the duration and level of hyperglycaemia. Diabetic neuropathy is a common serious complication of diabetes and it can also lead to foot ulceration because of insensitive foot and an increased risk of falling.

The postural instability was confirmed in the laboratory setting. Subjects with peripheral neuropathy(PN) balanced less reliably on one foot for three seconds than when compared to control subjects without PN[32].

Common treatments for diabetic neuropathy are Glycemic control, weight control, pain relieving modalities(TENS and IFT), balance training to improve balance impairment, strength training to improve the strength of weak muscles and foot care to prevent and manage foot problems[35].

Van Deuresan et al.,(1999)in his study concluded that in peripheral neuropathy, alteration in input affects the postural tone and leads to disturbance in balance, it also decreases the sensation in the plantar surface of the feet because of damages in the receptors of joint position and perception of movement, Thus it leads to risk of cutaneous injuries and later leads to risk of fall related injuries due to balance disturbance. Motor nerves are involved and results in decreased muscle power thereby resulting in poor balance[39].

Lower limb diabetic peripheral neuropathy has an adverse effect on postural stability and walking. Lower extremity exercise and balance training improves the balance in patients with diabetic peripheral neuropathy[8].

Anne Shumway cook et al.,(2000)recommended from their study that the implementation of new balance retraining program improves stability with the use of dual task training. Since cognitive spatial processing relies on neural mechanisms which are also necessary for the regulation of standing posture, they suggested that cognitive processing influences balance ability[12].

This study intends to know the effect of balance training program which consists of balancing activities with cognitive task as a secondary task in improving balance and dual task performance of patients with diabetic peripheral neuropathy. Both tasks will be given concurrently.

1.1 NEED FOR THE STUDY

Improving the balance measure in patients with diabetic peripheral neuropathy is the main aim of researchers and incorporating dual task training in improving balance is focus of current research.

Dual task is involving in two activities, which is very common in daily living.

Dual task training has been done in patients with chronic stroke and in older age populations to improve the balance and dual task reaction time[40].

Automaticity implies that a task is performed without attentional resources[26]. Usually, postural control has been considered an automatic response to vestibular, visual, and proprioceptive information[21].

More recent research provides evidence that the regulation of posture involves cognitive as well as sensory processes. Dual-task methodology which needs participants to perform two or more concurrent tasks, has been used to examine the attentional demands of postural activities[2, 18, 22, 38,7].

Kerr et al.,(1985) found that a concurrent standing balance task disrupted recall on a spatial memory task[18].

Walking may be considered a relatively automatic activity because of existence of central pattern generators (CPGs) which are the self-sustaining spinal networks. The difference between CPGs in humans compared with other animals is that there is increased influence of cortico-spinal pathways in humans. However, walking is seldom steady state and higher braincentres are involved. Thus, walking requires the use of a proportion of the information processing capacity of the central nervous system, known as attentional capacity.

Paul et al(2009)., Dual-task paradigms are used to study the degree of automaticity of movement. In this a primary task is undertaken like walking, Secondary tasks are added and the resultant effect on both tasks are examined. In day-to-day situations it is normal for more than one task to be undertaken concurrently,for instance, walking and talking. Thus these situations are in effect dual-task paradigms[28].

Because of loss of somato-sensory input from periphery, diabetic patients have difficulty in maintaining balance in standing, walking and activities done with more than one task. So, training the patients with dual task improves balance and dual task performance.

Therefore, this study mainly focused on the effect of dual task training and single task training in improving balance and dual task performance of individuals with diabetic peripheral neuropathy

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1. DIABETIC PERIPHERAL NEUROPATHY

Pinzur MS.(2011) suggested that Diabetic peripheral neuropathy affects one third of adults with diabetes. Preventive strategies after DPN proved to decrease the potential risk for the development of diabetic foot ulcers, foot infection, Charcot foot, or amputation[29].

Ashok et al (2002)., aimed to study the prevalence of risk factors for neuropathy in south Indian population by biothesiometry and results suggested that the prevalence of neuropathy in type 2 diabetic south Indian subjects is 19.1%, age and duration of disease is the main risk factor for neuropathy[5].

Simoneau et al(1995)., investigated the effects of somato-sensory deficits on the control of balance during quiet stance using subjects with demonstrated loss of sensation to touch, joint movement perception, proprioception, and other somatosensory stimuli secondary to diabetic neuropathy. The results indicate that somato-sensory deficits resulting from diabetic neuropathy lead to a marked decrease in the ability to maintain a stable stance position because somato-sensory input contributes 60 – 75% of control[37].

M. J. Young et al., (1993)did a prevalence study in patients with diabetic peripheral neuropathy in clinics in UK and concluded that DPN is a complication of diabetes. It increases with age and duration of disease, andis present in more than 50% of diabetic patients[41].

2.2. MICHIGAN NEUROPATHY SCREENING INSTRUMENT(MNSI)

Ali Moghtaderi et al., (2006)screened 179 patients with type 2 diabetes mellitus by using MNSI over a 2 years period and concluded that the accuracy of MNSI has high specificity ratio over five and moderate to good post test probability[3].

Eva L Feldman, MD, PHD et al., (1994) havedesigned to facilitate the diagnosis of diabetic neuropathy and results shows that MNSI score more than 2 is suggestive of neuropathy. And they concluded that MNSI is a good screening tool for diabetic neuropathy[9].

2.3. BALANCE IMPAIREMENT IN DIABETIC PERIPHERAL NEUROPATHY

Steven morrison, PhD et al (2010) did a study with Sixteen patients with type 2 diabetes and twenty age-matched control subjects and assessed Postural stability and falls risk. They found that individuals with diabetes had impaired balance, slower reactions, and consequently a higher falls risk than age-matched control subjects[36].

L. Paul et al.,(2009)studied and concluded that the lack of sensory information from the periphery in DPN results in people using their attentional capacity to maintain their gait, thus leaving less reserve capacity for other simultaneous cognitive tasks[28].

Ali Cimbiz and OzgeCakir., (2004) study results shows that the diabetic neuropathy disturbed especially the balance on the dominant leg[4].

Simoneau CG et al.,(1995)concluded that loss of sensory perception secondary to diabetic distal symmetrical sensory neuropathy has a markedly detrimental effect on postural stability[37].

2.4. BALANCE TRAINING IN DIABETIC PHERIPHERAL NUROPATHY

L. Allet et al., (2010) studied that specific training inclusive of balance exercises and strength training can improve gait speed, balance, muscle strength and joint mobility in diabetic neuropathy patients[1].

James K Richardson and his colleagues(2000)suggested that 3 weeks of specific brief balance exercise regimen improves the clinical measures of balance in patients with diabetic neuropathy[13].

2.5. DUAL TASK TRAINING

Karen Z. H et al, (2010) suggested form their study in older adults, that cognitive dual task training improved gross motor performance. This result supports the view that motor control in aging is influenced by executive control and has implication for theories of cognitive training and transfer[17].

Julie K. Rankin et al, (2000) suggested from his studies that dual task training program may be an appropriate intervention choice for the improvement of postural control in specific sub population of patients with balance impairments. The goal of this dual task training program would be to re-establish or increase the efficiency of synaptic pathway to allocate adequate attention to balance tasks even when secondary cognitive tasks are being performed[12].

Patimasilsupadol et al, (2009)suggested from his study that 4 weeks of dual task balance training with variable priority instruction was more effective in improving both balance and dual task performance under dual task condition than dual task with fixed priority instruction and single task balance training strategies in older adults with impaired balance[31].

L. Paul et al.,(2009)studied and concluded that the lack of sensory information from the periphery in DPN results in people using their attentional capacity to maintain their gait, thus leaving less reserve capacity for other simultaneous cognitive tasks[28].

. **Geraldin L. Pellecehia(1991)**studied the effect of dual task training for three sessions compared with no training group and single task training group and concluded that after training, performance of a concurrent cognitive task increased postural sway in no training group and single task training group but not in the dual task training group. And results suggested that dual task practice improves dual task performance[27].

2.6.OUTCOME MEASURES

Martin Hofheinz (2010) examined the validity and reliability of the Timed Up and Go Test with dual task for predicting the risk of falls and balance with 120 subjects. The study results suggest that tests with dual task can be recommended because they possess high criterion validity and very good retest reliability[25].

Ali Cimbiz et al.,(2005)used dominant and non dominant leg stance and functional reach test to assess the balance and risk of fall in sixty patients with diabetic neuropathy. And they suggested that it was a good tool to assess the balance in patients with DPN[4].

David Sandman, BS et al.,(2001) used unipedal stance test, functional reach test and tandom stance test to measure balance and to assess improvement in balance measures after exercise training in patients with peripheral neuropathy.

James C. Wall., (2000) noted that Time up and go test measures the overall time to complete a series of functionally important tasks and it is a practical, objective, assessment tool that can be used in almost any clinical setting with minimal equipment and professional expertise[14].

Podsiadlo D and Richardson S(1991)., study data suggests that the timed "Up & Go" test is a reliable and valid test for quantifying functional mobility that may also be useful in following clinical change over time and the test is quick, requires no special equipment or training, and is easily included as part of the routine medical examination[27].

Franchignoni, Felt al, (1998) did a validity study and povied the results that The One-Legged Stance Test measures postural stability and among five other tests of balance and mobility, reliability of the One-Legged Stance Test was examined for 45 healthy females 55 to 71 years old and found to have "good" intraclass correlations coefficients (ICC range = .95 to .099). Within raters ICC ranged from 0.73 to 0.93[11].

James k. Richardson et al.,(1996)did a study with moderate peripheral neuropathy patients, and he concluded that unipedal stance test is a reliable test to assess the risk of fall and to verify the functional significance of impaired distal sensation[13].

AIM AND OBJECTIVES

3. AIM AND OBJECTIVES

3.1. AIM

To compare the effect of dual task training and single task training in improving balance and dual task performance of individuals with diabetic peripheral neuropathy.

3.2. OBJECTIVES

- To evaluate the effect of dual task training in improving balance of individuals with diabetic peripheral neuropathy
- To evaluate the effect of single task training in improving balance of individuals with diabetic peripheral neuropathy.
- To compare the effect of dual task training and single task training of improving balance in individuals with diabetic peripheral neuropathy.
- To evaluate the effect of dual task training of improving dual task performance of individuals with diabetic peripheral neuropathy.
- To evaluate the effect of single task training in improving dual task performance of individuals with diabetic peripheral neuropathy
- To compare the effect of dual task training and single task training in improving dual task performance of individuals with diabetic peripheral neuropathy.

METERIALS AND METHODOLOGY

4. MATERIALS AND METHODOLOGY

4.1. STUDY DESIGN

Two group pre test and post test experimental study.

4.2. SAMPLING TECHNIQUE

Simple random sampling.

4.3. SAMPLE SIZE

20 subjects, satisfying the inclusion criteria with 10 subjects in each group.

Group A – 10 subjects

Group B– 10 subjects

4.4. STUDY SETTING

Kovai Medical Centre and Hospital, Coimbatore.

Home setting.

4.5. CRITERIA FOR SELECTION

4.5.1. INCLUSION CRITERIA

- Individuals with Type 2 (Non insulin dependent diabetes mellitus).
- FPG ≥126 mg/dl (7.0 mmol/l)
- Both sexes.
- MNSI score>2
- Age 45-65 years.
- BMI>18
- MMSE>24

4.5.2. EXCLUSION CRITERIA

- Individuals with IDDM
- MNSI<2
- MMSE<24

- Age <45 or >65
- Fracture of dislocation in lower limbs.
- Rheumatic arthritis and Pyogenic arthritis.
- Charcotsarthropathy
- Peripheral vascular disease.
- CNS dysfunction (hemiparesis, myelopathy, cerebellar ataxia)
- Significant musculoskeletal deformity(amputation, scoliosis, myopathy)
- Demyelinating and degenerative disease of brain.
- Hearing and visual deficits.
- Symptomatic postural hypotension.
- A history of evidence on physical examination of plantar skin pressure ulcer.
- Cardio myopathyies.
- Vestibular problems.

4.6. HYPOTHESIS

4.6.1. NULL HYPOTHESIS

- H_{01} There is no significant effect of dual task training in improving balance of individuals with diabetic peripheral neuropathy.
- H_{02} There is no significant effect of single task training in improving balance of individuals with diabetic peripheral neuropathy.
- H_{03} There is no significant differences between dual task training and single task training of individuals with diabetic peripheral neuropathy.
- H_{04} There is no significant effect of dual task training in improving dual task performance of individuals with diabetic peripheral neuropathy.
- H_{05} There is no significant effect of single task training in improving dual task performance of individuals with diabetic peripheral neuropathy.
- H_{06} There is no significant differences between dual task training and single task training in improving dual task performance of individuals with diabetic peripheral neuropathy.

4.6.2. ALTERNATIVE HYPOTHESIS

- H_{A1} There is significant effect of dual task training in improving balance of individuals with diabetic peripheral neuropathy.
- H_{A2} There is significant effect of single task training in improving balance of individuals with diabetic peripheral neuropathy.
- H_{A3} There is significant differences between dual task training and single task training of individuals with diabetic peripheral neuropathy
- H_{A4} There is significant effect of dual task training in improving dual task performance of individuals with diabetic peripheral neuropathy.
- H_{A5} There is significant effect of single task training in improving dual task performance of individuals with diabetic peripheral neuropathy.
- H_{A6} There is significant differences between dual task training and single task training in improving dual task performance of individuals with diabetic peripheral neuropathy.

4.7. STUDY METHOD

4.7.1. TREATMENT DUARATION

GROUP A – 30 minutes of dual task training both balance exercises and cognitive task concurrently

GROUP B – 30 minutes of single task training only balance exercises.

4.7.2. TREATMENT PROCEDURE

Totally 30 patients who comes under inclusion criteria will be selected, out of these 20 patients, 10 patients will be selected as dual task balance training group and 10 patients will be selected as single task training group.

Before training and at the end of the training, for both groups balance measures were measured by Sharpen Romberg test, single leg stance time and dual task performance is measured by timed up and go test.

4.7.3. TREATMENT DURATION

5 sessions a week for 4 weeks.

- Group A - 30 minutes a day of balance exercises with cognitive task done concurrently.
- Group B - 30 minutes a day of balance exercises.

4.7.4. GROUP A-DUAL TASK TRAINING: Each exercises repeated 10 times and 5 sessions in a week for 4 weeks. All the exercises done by counting the numbers in backward by 2s starting from 50. Rest is dependent on patients need.

Warm up (open chain ankle ROM exercise) subjects asked to write the alphabet in the air with each foot by moving the ankle.

Standing exercises were given:

- Toe standing.
- Tandom standing
- Heel standing

Walking exercises were given:

- Toe walking
- Tandem forward walk
- Heel walk
- Cross-over walk
- Tandem backward walk

Level 1.Can use one hand to steady when performing the exercise.
Level 2.Can use no hands unless losing the balance when performing the exercise.
Level 3.Eyes closed and can use no hands unless losing the balance when performing the exercise

4.7.5. GROUP B-SINGLE TASK TRAINING: each exercises repeated 10 times and 3 times in a week for 4 weeks. Rest is dependent on patients need.

Warm up (open chain ankle ROM exercise) subjects wrote the alphabet in the air with each foot by moving the ankle.

Standing exercises were given:

- Toe standing.
- Tandom standing
- Heel standing

Walking exercise were given:

- Toe walking
- Tandem forward walk
- Heel walk
- Cross-over walk
- Tandem backward walk

Level 1.Can use one hand to steady when performing the exercise.
Level 2.Can use no hands unless losing the balance when performing the exercise.
Level 3.Eyes closed and can use no hands unless losing the balance when performing the exercise

4.8. OUT COME MEASURES

- Sharpen Romberg test in seconds (eyes closed)
- Single leg stance time in seconds(eyes open and eyes closed, right side and left side)
- Time up and go test in seconds (TUG-DT)

PHOTOGRAPHIC PRESENTAION

SINGLE LEG STANCE TEST

TIMED UP AND GO TEST

TANDEM WALKING

TOE STANDING

4.9. SATISTICAL ANALYSIS

The changes within the group A and group B were analysed using paired'‘t’ test and independent ‘t’ test.

INDEPENDENT `t’ TEST (between groups)

$$t = \frac{\overline{X1} - \overline{X2}}{S}\sqrt{\frac{n_1 n_2}{(n_1 + n_2)}}$$

Where,

$$S = \sqrt{\frac{\sum d_1^2 + \sum d_2^2}{n_1 + n_2 - 2}}$$

PAIRED `t’ TEST (within groups)

$$t = \frac{\bar{d}\sqrt{n}}{S}$$

Where,

$$S = \sqrt{\frac{\sum d^2 - \left[\bar{d}\right]^2 \times n}{n - 1}}$$

S=combined standard deviation

$d_1 \& d_2$ =difference between initial & final readings in group A &group B

respectively.

n_1 & n_2=number of patients in group A & group B respectively

$\overline{X_1} \& \overline{X_2}$ =Mean of group A & group B respectively

DATA ANALYSIS

5. DATA PRESENTATION

5.1. TABULAR PRESENTATION

SHARPENED ROMBERG TEST-EYES CLOSED:

PAIRED 'T' TEST:

GROUP I – DUAL TASK TRAINING GROUP:

	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	12.316	10.732	2.262	At 5% Significant
POST-TEST	32.636			

GROUP II – SINGLE TASK TRAINING GROUP

	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	11.669	14.27	2.262	At 5% Significant
POST-TEST	23.944			

INDEPENDENT 'T' TEST:

PRE TEST:

GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
DUAL TASK GROUP	12.316	0.252	2.101	At 5% Not Significant
SINGLE TASK GROUP	11.669			

POST TEST:

GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
DUAL TASK GROUP	32.636	2.447	2.101	At 5% Significant
SINGLE TASK GROUP	23.944			

SINGLE LED STANCE TEST-EYES OPENED-RIGHT SIDE:

PAIRED 'T' TEST:

GROUP I – DUAL TASK TRAINING GROUP:

GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	4.953	12.091	2.262	At 5% Significant
POST-TEST	28.884			

GROUP II – SINGLE TASK TRAINING GROUP:

GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	5.296	7.508	2.262	At 5% Significant
POST-TEST	15.665			

INDEPENDENT 'T' TEST:

PRE TEST:

GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
DUAL TASK GROUP	4.711	0.571	2.101	At 5% Not Significant
SINGLE TASK GROUP	5.296			

POST TEST:

GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
DUAL TASK GROUP	26.798	4.561	2.101	At 5% Significant
SINGLE TASK GROUP	15.665			

SINGLE LED STANCE TEST-EYES CLOSED-RIGHT SIDE:

PAIRED 'T' TEST:

GROUP I – DUAL TASK TRAINING GROUP:

GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	2.6480	26.883	2.262	At 5% Significant
POST-TEST	25.488			

GROUP II – SINGLE TASK TRAINING GROUP:

GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	4.132	37.67	2.262	At 5% Significant
POST-TEST	14.714			

INDEPENDENT ‘T’ TEST:

PRE TEST:

GROUPS	MEAN	‘t’ VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED ‘t’ VALUE	TABLE ‘t’ VALUE	
DUAL TASK GROUP	2.648	1.454	2.101	At 5% Not Significant
SINGLE TASK GROUP	4.132			

POST TEST:

GROUPS	MEAN	‘t’ VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED ‘t’ VALUE	TABLE ‘t’ VALUE	
DUAL TASK GROUP	25.488	7.579	2.101	At 5% Significant
SINGLE TASK GROUP	14.714			

SINGLE LED STANCE TEST-EYES OPENED-LEFT SIDE:

PAIRED 'T' TEST:

GROUP I – DUAL TASK TRAINING GROUP:

GROUP I	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	4.711	12.114	2.262	At 5% Significant
POST-TEST	26.798			

GROUP II – SINGLE TASK TRAINING GROUP:

GROUP II	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	4.65	10.317	2.262	At 5% Significant
POST-TEST	16.595			

INDEPENDENT 'T' TEST:

PRE TEST:

GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
DUAL TASK GROUP	4.953	0.262	2.101	At 5% Not Significant
SINGLE TASK GROUP	4.65			

POST TEST:

GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
DUAL TASK GROUP	28.884	5.17	2.101	At 5% Significant
SINGLE TASK GROUP	16.595			

SINGLE LED STANCE TEST-EYES CLOSED-LEFT SIDE:

PAIRED 'T' TEST:

GROUP I – DUAL TASK TRAINING GROUP:

GROUP I	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	2.216	15.34	2.262	At 5% Significant
POST-TEST	27.039			

GROUP II – SINGLE TASK TRAINING GROUP:

GROUP II	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	2.583	14.067	2.262	At 5% Significant
POST-TEST	13.569			

INDEPENDENT 'T' TEST:

PRE TEST:

GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
DUAL TASK GROUP	2.216	0.771	2.101	At 5% Not Significant
SINGLE TASK GROUP	2.583			

POST TEST:

GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
DUAL TASK GROUP	27.039	8.001	2.101	At 5% Significant
SINGLE TASK GROUP	13.569			

TIMED UP AND GO TEST-DUAL TASK:

PAIRED 'T' TEST:

GROUP I – DUAL TASK TRAINING GROUP:

GROUP I	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	31.863	6.585	2.262	At 5% Significant
POST-TEST	15.109			

GROUP II – SINGLE TASK TRAINING GROUP:

GROUP II	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
PRE-TEST	33.31	5.405	2.262	At 5% Significant
POST-TEST	20.25			

INDEPENDENT 'T' TEST:

PRE TEST:

GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
DUAL TASK GROUP	31.863	0.402	2.101	At 5% Not Significant
SINGLE TASK GROUP	33.31			

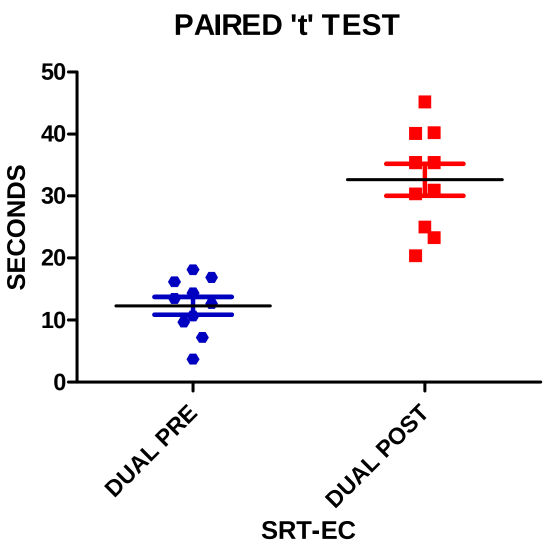
POST TEST:

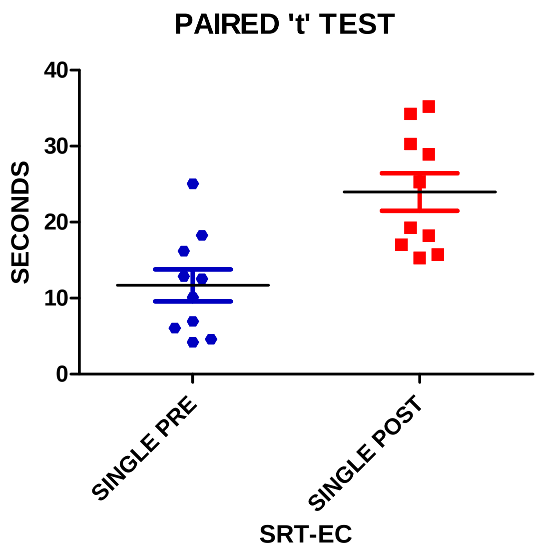
GROUPS	MEAN	't' VALUE		LEVEL OF SIGNIFICANCE
		CALCULATED 't' VALUE	TABLE 't' VALUE	
DUAL TASK GROUP	15.41	2.425	2.101	At 5% Significant
SINGLE TASK GROUP	20.21			

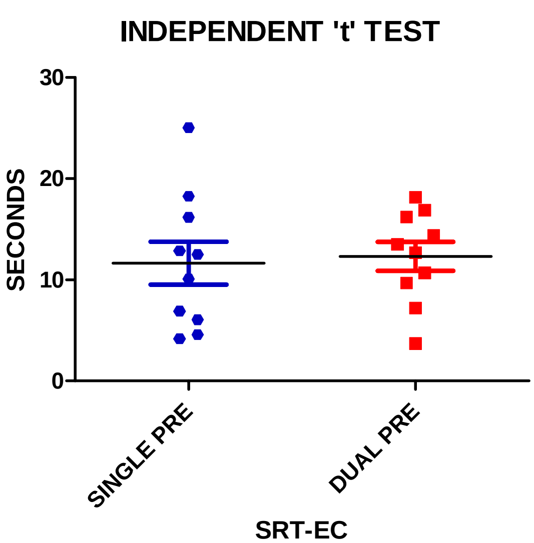
GRAPHICAL REPRESENTATION

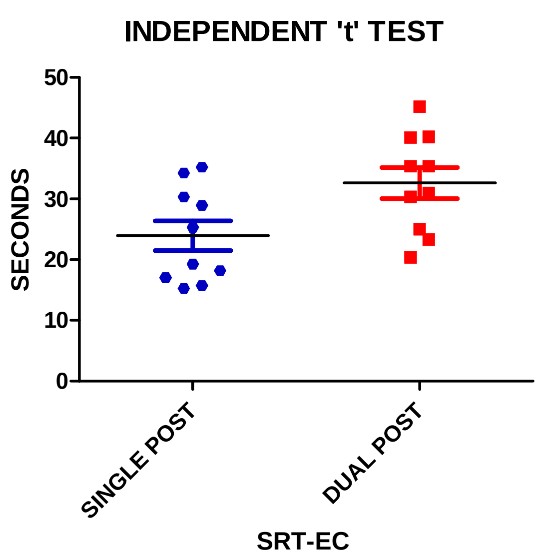
5.2. GRAPHICAL PRESENTATION

SHARPENED ROMBERG TEST-EYES CLOSED:

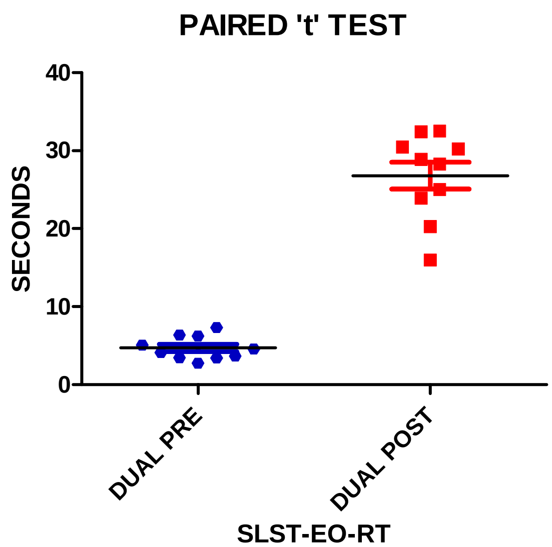


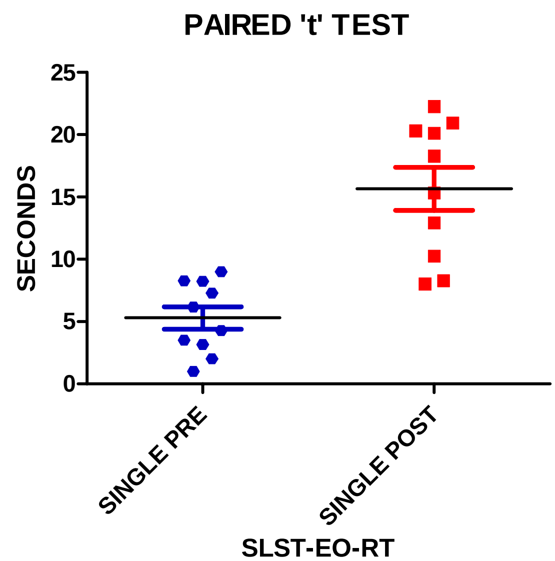


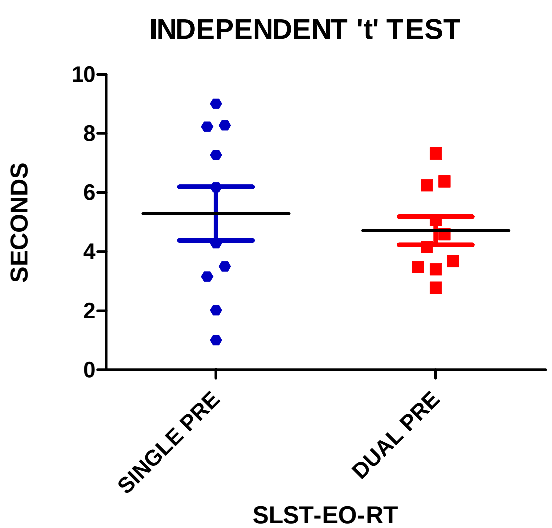


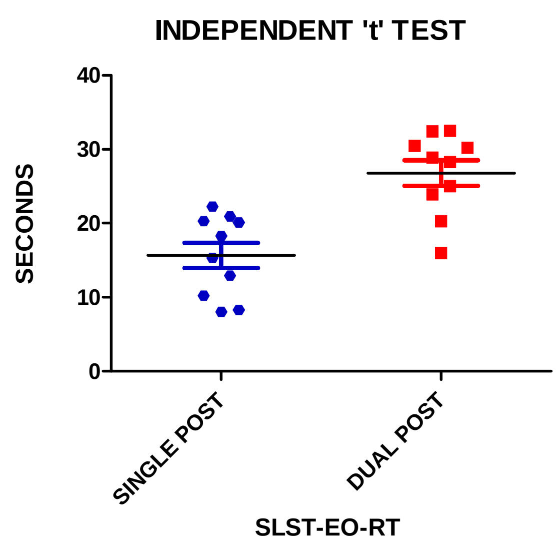


SINGLE LED STANCE TEST-EYES OPENED-RIGHT SIDE:

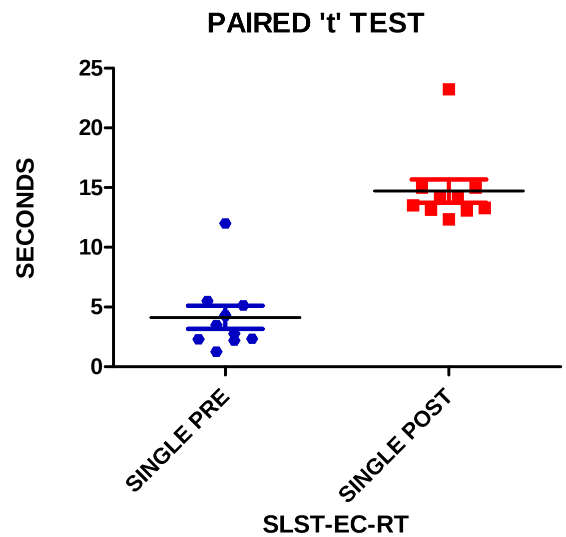




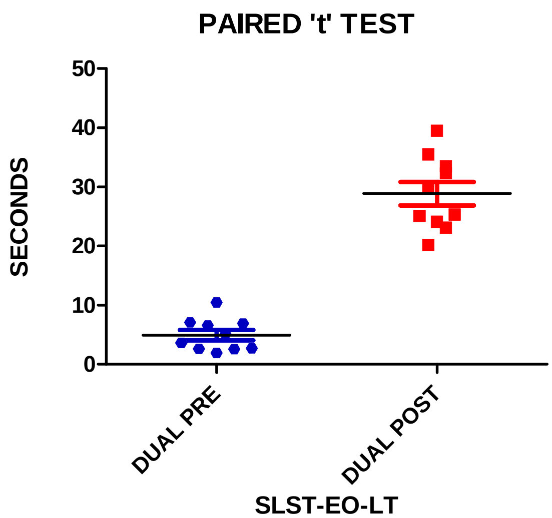


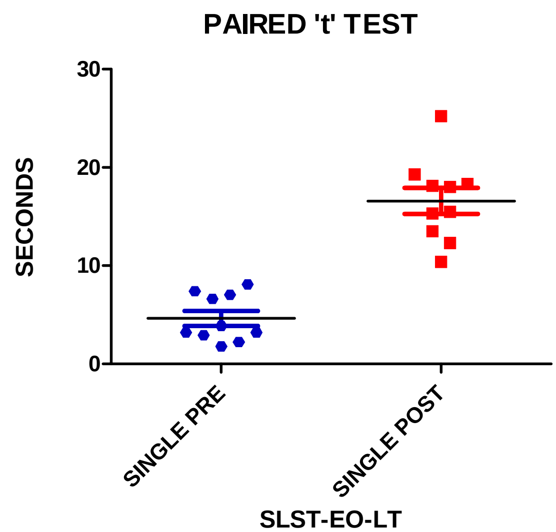


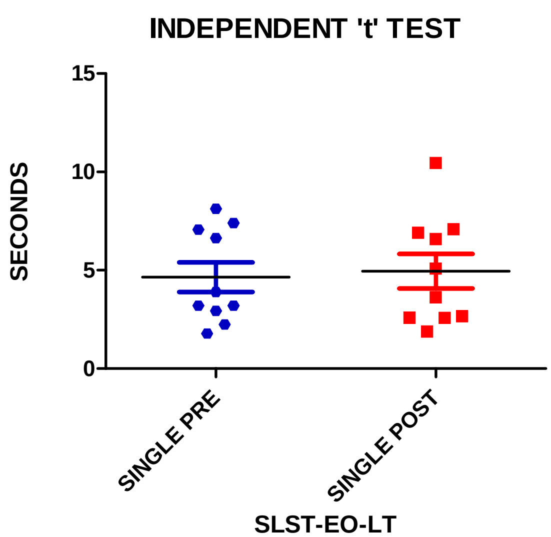
SINGLE LED STANCE TEST-EYES CLOSED-RIGHT SIDE:

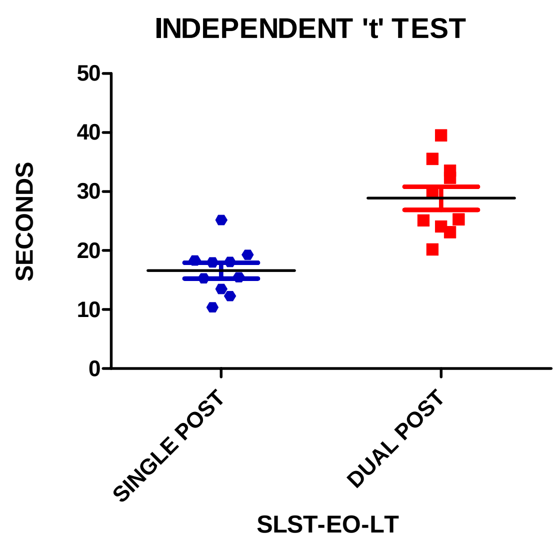


SINGLE LED STANCE TEST-EYES OPENED-LEFT SIDE:

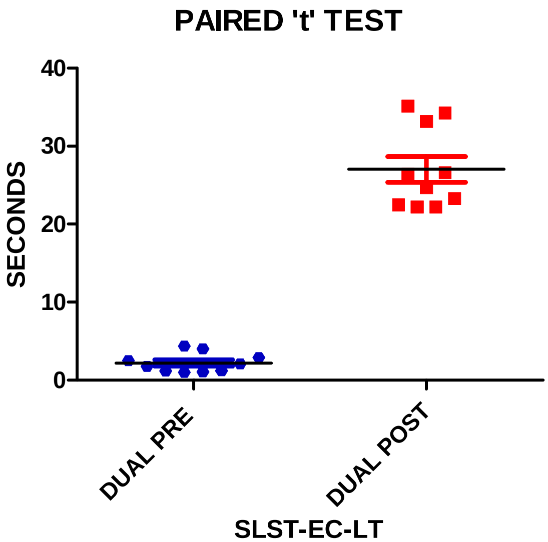


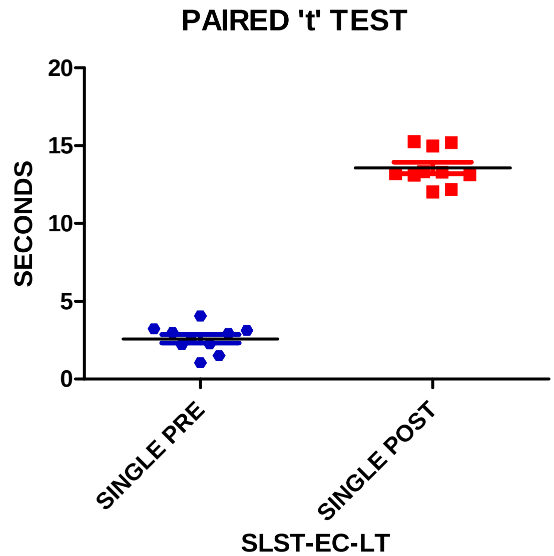


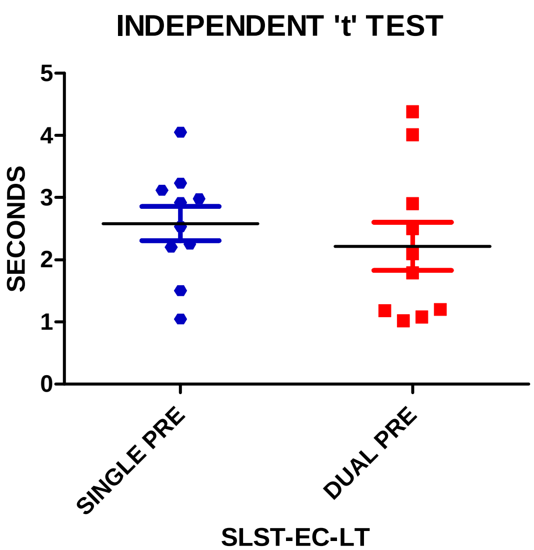


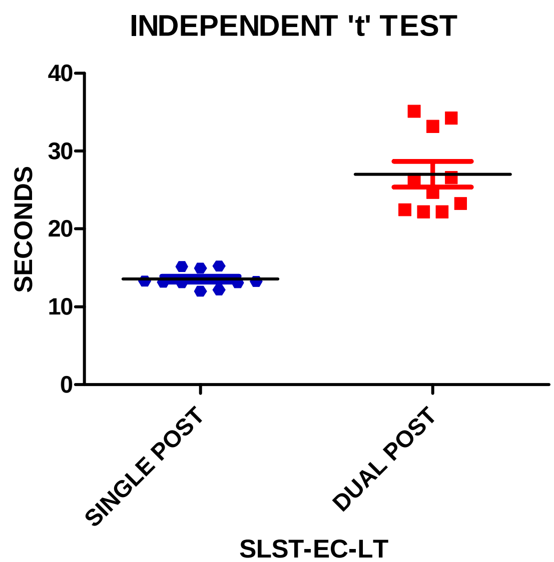


SINGLE LED STANCE TEST-EYES CLOSED-RIGHT SIDE:

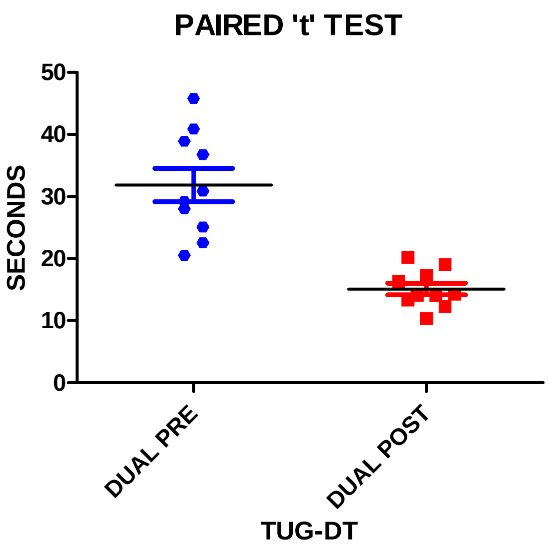


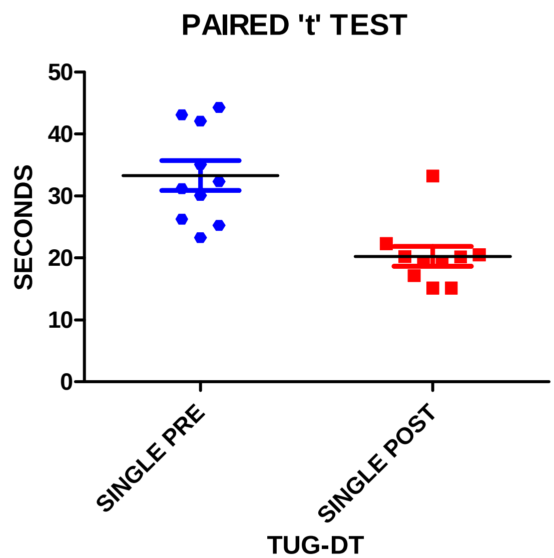


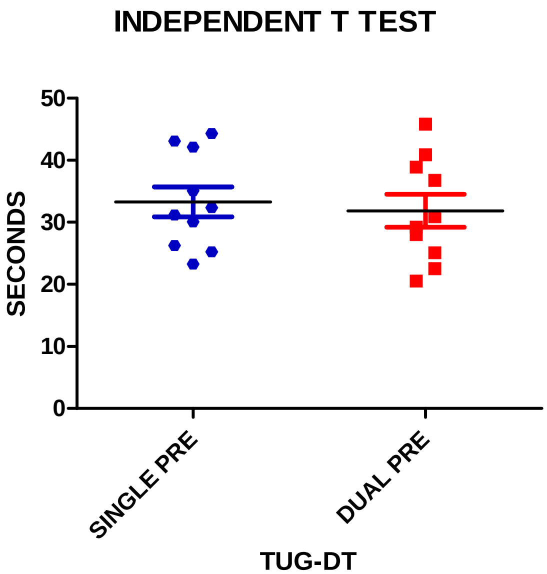


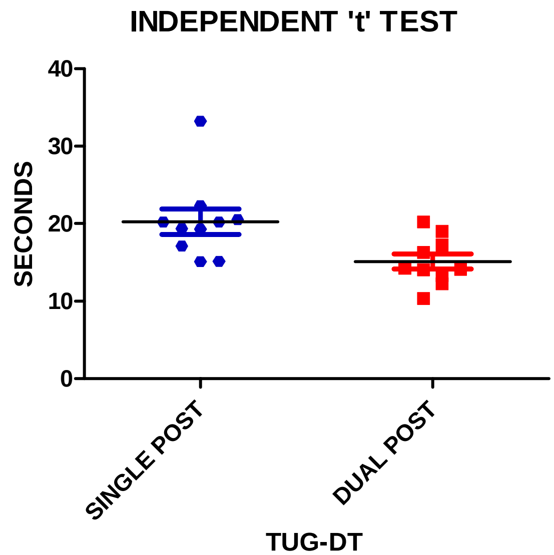


TIMED UP AND GO TEST-DUAL TASK:









DATA INTERPRETATION AND RESULTS

6. DATA ANALYSIS AND RESULTS:

SHARPENED ROMBERG TEST-EYES CLOSED:

PAIRED 't' TEST:

GROUP I – DUAL TASK TRAINING GROUP:

The pre test and post test values of sharpened Romberg test-eyes closed was analysed using paired 't' test. For 9 degrees of freedom and at 5% level of significance, the table 't' value is 2.262 and the calculated 't' value was 10.732. As the calculated 't' value was greater than the table 't' value, null hypothesis was rejected . Hence there was significant effect of dual task training in individuals with diabetic peripheral neuropathy.

GROUP II – SINGLE TASK TRAINING GROUP:

The pre test and post test values of sharpened Romberg test-eyes closed was analysed using paired 't' test. For 9 degrees of freedom and at 5% level of significance, the table 't' value is 2.262 and the calculated 't' value was 14.27. As the calculated 't' value was greater than the table 't' value, null hypothesis was rejected . Hence there was significant effect of single task training in individuals with diabetic peripheral neuropathy.

INDEPENDENT 't' TEST:

PRE TEST VALUES:

The pre test values of both the groups were analysed using independent 't' test. For 18 degrees of freedom and 5% level of significance, the table 't' value 2.101 and the calculated 't' value is 0.252. As the calculated 't' value was lesser than the table 't' value, there was no significant difference between the pre test values of both groups. Hence there was homogenicity between both the groups before the experiment.

POST TEST VALUES

The post test values of both the groups were analysed using independent ‘t’ test. For 18 degrees of freedom and 5% level of significance, the table ‘t’ value 2.101 and the calculated ‘t’ value is 2.447. As the calculated ‘t’ value was greater than the table ‘t’ value, null hypothesis rejected. Hence there was significant difference between the effectiveness of dual task training and single task training in individuals with diabetic peripheral neuropathy.

SINGLE LED STANCE TEST-EYES OPENED-RIGHT SIDE:

PAIRED ‘t’ TEST:

GROUP I – DUAL TASK TRAINING GROUP:

The pre test and post test values of single leg stance test- eyes opened-right side was analysed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table ‘t’ value is 2.262 and the calculated ‘t’ value was 12.091. As the calculated ‘t’ value was greater than the table ‘t’ value, null hypothesis was rejected . Hence there was significant effect of dual task training in individuals with diabetic peripheral neuropathy.

GROUP II – SINGLE TASK TRAINING GROUP:

The pre test and post test values of single leg stance test -eyes opened -right side was analysed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table ‘t’ value is 2.262 and the calculated ‘t’ value was 7.508. As the calculated ‘t’ value was greater than the table ‘t’ value, null hypothesis was rejected . Hence there was significant effect of single task training in individuals with diabetic peripheral neuropathy.

INDEPENDENT ‘t’ TEST:

PRE TEST VALUES:

The pre test values of both the groups were analysed using independent ‘t’ test. For 18 degrees of freedom and 5% level of significance, the table ‘t’ value 2.101 and the calculated ‘t’ value is 0.571. As the calculated ‘t’ value was lesser than the table ‘t’ value, there was no significant difference between the pre test values of both groups. Hence there was homogenicity between both the groups before the experiment.

POST TEST VALUES

The post test values of both the groups were analysed using independent ‘t’ test. For 18 degrees of freedom and 5% level of significance, the table ‘t’ value 2.101 and the calculated ‘t’ value is 4.561. As the calculated ‘t’ value was greater than the table ‘t’ value, null hypothesis rejected. Hence there was significant difference between the effectiveness of dual task training and single task training in individuals with diabetic peripheral neuropathy.

SINGLE LED STANCE TEST-EYES CLOSED-RIGHT SIDE:

PAIRED ‘t’ TEST:

GROUP I – DUAL TASK TRAINING GROUP:

The pre test and post test values of single leg stance test -eyes closed-right side was analysed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table ‘t’ value is 2.262 and the calculated ‘t’ value was 26.883. As the calculated ‘t’ value was greater than the table ‘t’ value, null hypothesis was rejected . Hence there was significant effect of dual task training in individuals with diabetic peripheral neuropathy.

GROUP II – SINGLE TASK TRAINING GROUP:

The pre test and post test values of single leg stance test -eyes closed -right side was analysed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table ‘t’ value is 2.262 and the calculated ‘t’ value was 37.67. As the calculated ‘t’ value was greater than the table ‘t’ value, null hypothesis was rejected . Hence there was significant effect of single task training in individuals with diabetic peripheral neuropathy.

INDEPENDENT ‘t’ TEST:

PRE TEST VALUES:

The pre test values of both the groups were analysed using independent ‘t’ test. For 18 degrees of freedom and 5% level of significance, the table ‘t’ value 2.101 and the calculated ‘t’ value is 1.454. As the calculated ‘t’ value was lesser than the table ‘t’ value, there was no significant difference between the pre test values of both groups. Hence there was homogenicity between both the groups before the experiment.

POST TEST VALUES

The post test values of both the groups were analysed using independent 't' test. For 18 degrees of freedom and 5% level of significance, the table 't' value 2.101 and the calculated 't' value is 7.579. As the calculated 't' value was greater than the table 't' value, null hypothesis rejected. Hence there was significant difference between the effectiveness of dual task training and single task training in individuals with diabetic peripheral neuropathy.

SINGLE LED STANCE TEST-EYES OPENED-LEFT SIDE:

PAIRED 't' TEST:

GROUP I – DUAL TASK TRAINING GROUP:

The pre test and post test values of single leg stance test-eyes opened-left side was analysed using paired 't' test. For 9 degrees of freedom and at 5% level of significance, the table 't' value is 2.262 and the calculated 't' value was 12.114. As the calculated 't' value was greater than the table 't' value, null hypothesis was rejected . Hence there was significant effect of dual task training in individuals with diabetic peripheral neuropathy.

GROUP II – SINGLE TASK TRAINING GROUP:

The pre test and post test values of single leg stance test-eyes opened-left side wasanalysed using paired 't' test. For 9 degrees of freedom and at 5% level of significance, the table 't' value is 2.262 and the calculated 't' value was 10.317. As the calculated 't' value was greater than the table 't' value, null hypothesis was rejected . Hence there was significant effect of single task training in individuals with diabetic peripheral neuropathy.

INDEPENDENT 't' TEST:

PRE TEST VALUES:

The pre test values of both the groups were analysed using independent 't' test. For 18 degrees of freedom and 5% level of significance, the table 't' value 2.101 and the calculated 't' value is 0.262. As the calculated 't' value was lesser than the table 't' value, there was no significant difference between the pre test values of both groups. Hence there was homogenicity between both the groups before the experiment.

POST TEST VALUES

The post test values of both the groups were analysed using independent ‘t’ test. For 18 degrees of freedom and 5% level of significance, the table ‘t’ value 2.101 and the calculated ‘t’ value is 5.17. As the calculated ‘t’ value was greater than the table ‘t’ value, null hypothesis rejected. Hence there was significant difference between the effectiveness of dual task training and single task training in individuals with diabetic peripheral neuropathy.

SINGLE LED STANCE TEST-EYES CLOSED-LEFT SIDE:

PAIRED ‘t’ TEST:

GROUP I – DUAL TASK TRAINING GROUP:

The pre test and post test values of single leg stance test-eyes closed-left side was analysed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table ‘t’ value is 2.262 and the calculated ‘t’ value was 15.34. As the calculated ‘t’ value was greater than the table ‘t’ value, null hypothesis was rejected . Hence there was significant effect of dual task training in individuals with diabetic peripheral neuropathy.

GROUP II – SINGLE TASK TRAINING GROUP:

The pre test and post test values of single leg stance test-eyes closed-left side wasanalysed using paired ‘t’ test. For 9 degrees of freedom and at 5% level of significance, the table ‘t’ value is 2.262 and the calculated ‘t’ value was 14.067. As the calculated ‘t’ value was greater than the table ‘t’ value, null hypothesis was rejected . Hence there was significant effect of single task training in individuals with diabetic peripheral neuropathy.

INDEPENDENT ‘t’ TEST:

PRE TEST VALUES:

The pre test values of both the groups were analysed using independent ‘t’ test. For 18 degrees of freedom and 5% level of significance, the table ‘t’ value 2.101 and the calculated ‘t’ value is 0.771. As the calculated ‘t’ value was lesser than the table ‘t’ value, there was no significant difference between the pre test values of both groups. Hence there was homogenicity between both the groups before the experiment.

POST TEST VALUES:

The post test values of both the groups were analysed using independent 't' test. For 18 degrees of freedom and 5% level of significance, the table 't' value 2.101 and the calculated 't' value is 8.001. As the calculated 't' value was greater than the table 't' value, null hypothesis rejected. Hence there was significant difference between the effectiveness of dual task training and single task training in individuals with diabetic peripheral neuropathy.

TIMED UP AND GO TEST-DUAL TASK:

PAIRED 't' TEST:

GROUP I – DUAL TASK TRAINING GROUP:

The pre test and post test values of timed up and go test-dual task wasanalysed using paired 't' test. For 9 degrees of freedom and at 5% level of significance, the table 't' value is 2.262 and the calculated 't' value was 6.585. As the calculated 't' value was greater than the table 't' value, null hypothesis was rejected . Hence there was significant effect of dual task training in individuals with diabetic peripheral neuropathy.

GROUP II – SINGLE TASK TRAINING GROUP:

The pre test and post test values of timed up and go test-dual task was analysed using paired 't' test. For 9 degrees of freedom and at 5% level of significance, the table 't' value is 2.262 and the calculated 't' value was 5.405. As the calculated 't' value was greater than the table 't' value, null hypothesis was rejected . Hence there was significant effect of single task training in individuals with diabetic peripheral neuropathy.

INDEPENDENT 't' TEST:

PRE TEST VALUES:

The pre test values of both the groups were analysed using independent 't' test. For 18 degrees of freedom and 5% level of significance, the table 't' value 2.101 and the calculated 't' value is 0.402. As the calculated 't' value was lesser than the table 't' value, there was no significant difference between the pre test values of both groups. Hence there was homogenicity between both the groups before the experiment.

POST TEST VALUES:

The post test values of both the groups were analysed using independent 't' test. For 18 degrees of freedom and 5% level of significance, the table 't' value 2.101 and the calculated 't' value is 2.425. As the calculated 't' value was greater than the table 't' value, null hypothesis rejected. Hence there was significant difference between the effectiveness of dual task training and single task training in individuals with diabetic peripheral neuropathy.

DISCUSSION

7. DISCUSSION

In patients with diabetic peripheral neuropathy, physiotherapy interventions are aimed at optimizing patient safety and independence. Currently, the researchers in physiotherapy have become aware of the role that dual tasking plays in daily living. Diabetic neuropathy patients are at a risk of loosing balance and fall because of loss of somato-sensory input from the lower limb.

Woollacott at al.,found that older individuals, when compared with younger subjects had a decreased ability to balance when sensory information is reduced in case of diabetic neuropathy.

In this study, the training is mainly aimed to improve the balance and dual task performance of these patients. Typically therapeutic programs for balance control focused on a single task protocol.

Julie k Rankin et al., suggested that for a balance training program which involves a protocol beginning with single tasks and moving towards multitasks that progresses with difficulty and this multitask training program may be an appropriate intervention for the improvements of postural control in patients with DPN.

According to system theory of balance control the cognitive, sensory and motor aspects of balance must be integrated to sustain an upright posture. Generally CNS adjusts for diminished information from one sensory system by utilizing inputs from another sensory system to produce motor response. Concentrating on cognitive aspects of balance can improve balance better than training other systems alone.

Geraldine L. Pellecchia(2005) did a research in 18 participants assigned to no-training, single-task training, and dual-task training groups. Single-task training consisted of 3 sessions in which the postural task, quiet standing on a compliant surface, and the cognitive task, counting backward by 3s, were practiced seperately. Dual-task training consisted of 3 sessions of concurrent practice of the cognitive and postural tasks. After training, performanceof a concurrent cognitive task increased postural sway in the no-training and single-task training groups but not in the dual task training group. Results suggest that dual-task practice improves dual-task performance.

Several authors have suggested that procedures to assess and improve dual-task performance should be incorporated in fall prevention and rehabilitation programs. Performing anytask requires some portion of an individual’s attentional capacity. The attentional requirement of performing two tasks simultaneously is the sum of the attentional needs of the componenttasks. Dual-task interference occurs when the attentional demands of the two concurrently performed tasks exceed the available capacity. With practice, a skill may become more automatic. With greater automaticity, the attentional requirements of the practiced task are reduced, making more resources available for the second task.

Therefore, if the attentional requirements of postural control could be reduced during concurrent postural and cognitive tasks,then additional central resources would be available for carrying out an unrelated cognitive task. Consequently, dual task interference would be reduced.

Kramer AF et al., (1995) study results suggest that dual task training with variable priority improved significantly more than fixed priority when compared to single task training in old age group.

This study proves that both dual task automatization and integration of task occur as a result of training exercise protocol with dual task. So, patients have improvement in both balance and dual task performance. In single task training group, balance task is automatized thus clinical measure of balance is improved.In dual task training group, both automatization of individual tasks and integration of both tasks takes place and thus there is an improvement of balance and dual task performance.

According to many authors, central bottleneck mechanism is a reduction of reaction time of each task when we perform two tasks concurrently. This can be eliminated by practice of dual task.

Eric Ruthruffet al., (2006) did a study with three experimental groups (task1, task2 and dual task) and results suggest that participants had crossed the bottleneck by automatizing.

In this study also, results suggest that central bottleneck is bypassed by practice and thus there was a significant improvement on dual task performance following dual task training.

The pre test and post test values of both single task group and dual task group showed significant improvement of balance and dual task performance in sharpen Romberg test, single leg stance test and timed up and go test. But, dual task training group showed more significant improvement than single task training group in both balance and dual task performance. The small size sample and duration of the treatment is not enough for the detection of treatment effect. The implication of the findings in this study are important and should be confirmed in large sample size.

SUMMARY AND CONCLUSION

8. SUMMARY AND CONCLUSION

This study was to find out the effect of dual task training and single task training in improving balance and dual task performance of individuals with diabetic peripheral neuropathy. Twenty diabetic neuropathy patients were selected by Michigan diabetic neuropathy instrument and allotted to two groups by simple random sampling method and ten of them treated with dual task training and ten of them treated with single task training for four weeks. Balance is measured by sharpen Romberg test eyes closed and single leg stance test both right and left and eyes open and closed. Dual task performance is measure by timed up and go test-dual task. The was analyzed using‘t’test and result showed that both dual task and single task in improving balance and dual task performance, and dual task training has significant improvement when compared to single task training group. Hence it is concluded that adding secondary cognitive task in balance training have additional benefit of improving balance and dual task performance.

LIMITATIONS AND SUGGESTIONS

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.
- This simple measure for balance is not enough to measure the balance in these patients.
- These simple clinical tests are not applicable for patients who are having difficulty in walking and standing.
- Effect of aging is not taken into consideration.
- In this study, during dual task fixed priority has been set for prioritization of task but we did not measure how prioritization has been given by the patient.
- This study does not explain the improvements in clinical measure of balance is translated to decreased risk of fall

9.2. SUGGESTIONS

- Larger number of samples is suggested.
- Measures should be taken to exclude the effect of aging.
- Better measurement tool should be taken for the dual task performance.
- Training effects and carryover of these exercises should be assessed.
- Variable priority instructional set has been suggested.
- Clinical measure of fall risk should be taken.

APPENDICES

APPENDIX-I

MICHIGAN NEUROPATHY SCREENING INSTRUMENT

Physical Assessment (To be completed by health professional)

1. Appearance of Feet

	Right			**Left**	
a.	Normal	☐ 0 Yes ☐ 1 No		Normal	☐ 0 Yes ☐ 1 No

b. If no, check all that apply: If no, check all that apply:

Deformities	☐	Deformities	☐
Dry skin, callus	☐	Dry skin, callus	☐
Infection	☐	Infection	☐
Fissure	☐	Fissure	☐
Other	☐	Other	☐
specify: ____________________		specify: ______________________	

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

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

		Present	Decreased	Absent	Present	Decreased	Absent
4.	Vibration perception at great toe	☐ 0	☐ 0.5	☐ 1	☐ 0	☐ 0.5	☐ 1
		Normal	Reduced	Absent	Normal	Reduced	Absent
5.	Monofilament	☐ 0	☐ 0.5	☐ 1	☐ 0	☐ 0.5	☐ 1

Signature:____________________________________

Total Score ______________ /10 Points

HOW TO USE THE MICHIGAN NEUROPATHY SCREENING INSTRUMENT

For all assessments, the foot should be warm(>30°C).

Foot Inspection: The feet are inspected for evidence of excessively dry skin, callous formation, fissures, frank ulceration or deformities. Deformities include flat feet, hammer toes, overlapping toes, halux valgus, joint subluxation, prominent metatarsal heads, medial convexity (Charcot foot) and amputation.

Vibration Sensation: Vibration sensation should be performed with the great toe unsupported. Vibration sensation will be tested bilaterally using a 128 Hz tuning fork placed over the dorsum of the great toe on the boney prominence of the DIP joint. Patients, whose eyes are closed, will be asked to indicate when they can no longer sense the vibration from the vibrating tuning fork.

In general, the examiner should be able to feel vibration from the hand-held tuning fork for 5 seconds longer on his distal forefinger than a normal subject can at the great toe (e.g. examiner's DIP joint of the first finger versus patient's toe). If the examiner feels vibration for 10 or more seconds on his or her finger, then vibration is considered decreased. A trial should be given when the tuning fork is not vibrating to be certain that the patient is responding to vibration and not pressure or some other clue. Vibration is scored as 1) present if the examiner senses the vibration on his or her finger for < 10 seconds, 2) reduced if sensed for ≥ 10 or 3) absent (no vibration detection.)

Muscle Stretch Reflexes: The ankle reflexes will be examined using an appropriate reflex hammer (e.g. Trommer or Queen square). The ankle reflexes should be elicited in the sitting position with the foot dependent and the patient relaxed. For the reflex, the foot should be passively positioned and the foot dorsiflexed slightly to obtain optimal stretch of the muscle.

The Achilles tendon should be percussed directly. If the reflex is obtained, it is graded as present. If the reflex is absent, the patient is asked to perform the Jendrassic maneuver (i.e., hooking the fingers together and pulling). Reflexes elicited with the Jendrassic maneuver alone are designated "present with reinforcement." If the reflex is absent, even in the face of the Jendrassic maneuver, the reflex is considered absent.

Monofilament Testing: For this examination, it is important that the patient's foot be supported (i.e., allow the sole of the foot to rest on a flat, warm surface). The filament should initially be prestressed (4-6 perpendicular applications to the dorsum of the examiner's first finger). The filament is then applied to the dorsum of the great toe midway between the nail fold and the DIP joint. Do not hold the toe directly. The filament is applied perpendicularly and briefly, (<1 second) with an even pressure. When the filament bends, the force of 10 grams has been applied. The patient, whose eyes are closed, is asked to respond yes if he/she feels the filament. Eight correct responses out of 10 applications is considered normal: one to seven correct responses indicates reduced sensation and no correct answers translates into absent sensation.

APPENDIX- II - ASSESSMENT FORM

Name: Address:

Age: Occupation:

Sex: Phone number:

BMI:

Past medical history:

Present illness:

Foot ulcer: (present or absent)

Associated problems:

Known diabetic for past _____years

FPG:

Hearing deficits:

Visual acuity:

Michigan Neuropathy Screening Instrument: _____/10 points.

Mini mental state examination:

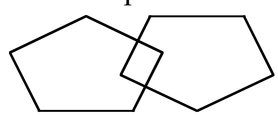
	Sharpen Romberg test(secs) (Eyes closed)	Single leg stance time (secs) (Eyes opened)		Single leg stance time(secs) (Eyes closed)		Time up and go test- DT(secs)
		rt	lt	rt	lt	
Pre Test						
Post Test						

APPENDIX- III

MINI-MENTAL STATE EXAMINATION (MMSE)

Patient'sName:____Date:_____________

Instructions:Scoreonepointforeachcorrectresponsewithineachquestionoractivity.

Maximum	**Patient's Score**	**Questions**
5		"Whatistheyear? Season? Date? Day? Month?"
5		"Wherearewenow? State? County? Town/city? Hospital? Floor?"
3		The examinernamesthreeunrelatedobjectsclearlyand slowly,then theinstructorasksthepatientto nameallthreeof them.Thepatient's responseis usedforscoring.Theexaminerrepeatsthemuntilpatient learnsallofthem,ifpossible.
5		"Iwouldlikeyoutocountbackwardfrom100bysevens."(93,86,79, 72,65,…) Alternative:"SpellWORLDbackwards."(D-L-R-O-W)
3		"EarlierItoldyouthenamesofthreethings. Canyoutellmewhat thosewere?"
2		Showthepatienttwosimpleobjects,suchasawristwatchandapencil, andaskthepatienttonamethem.
1		"Repeatthephrase:'Noifs,ands,orbuts.'"
3		"Takethepaperinyourrighthand,folditinhalf,andputitonthefloor." (Theexaminergivesthepatientapieceofblankpaper.)
1		"Pleasereadthisanddowhatitsays."(Writteninstructionis"Close youreyes.")
1		"Makeupandwriteasentenceaboutanything."(Thissentencemust containanounandaverb.)
1		"Pleasecopythispicture." (Theexaminergivesthepatientablank pieceofpaperandaskshim/hertodrawthesymbolbelow. All10 anglesmustbepresentandtwomustintersect.) 
30		TOTAL

Interpretation of the MMSE:

Meth	Score	Interpretation
SingleCutoff	<2	Abnormal
Ran ge	<2 1	Increasedoddsofdementia Decreasedoddsofdementia
Education	2 1 <2 3	Abnormalfor8th gradeeducation Abnormalforhighschooleducation Abnormalforcollegeeducation
Sever ity	24- 30 18- 23	Nocognitiveimpairment Mildcognitiveimpairment Severecognitiveimpairment

APPENDIX – IV

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

I voluntarily consent to participate in the research study named **“EFFECT OF DUAL TASK TRAINING AND SINGLE TASK TRAINING IN IMPROVING BALANCE AND DUAL TASK PERFORMANCE OF PATIENTS WITH DIABETIC PERIPHERAL NEUROPATHY” – AN EXPERIMENTAL STUDY**

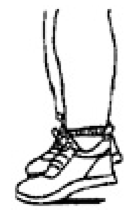
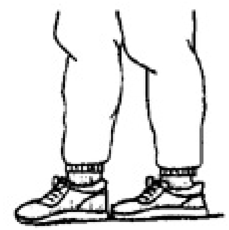
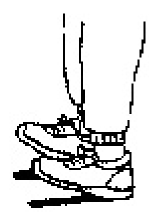
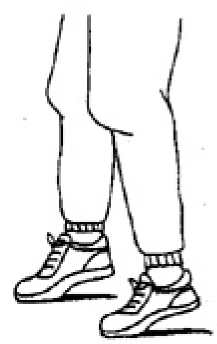
The researcher has explained to me the exercise approach in brief, risk of the participation and has answered the questions related to the research to my satisfaction.

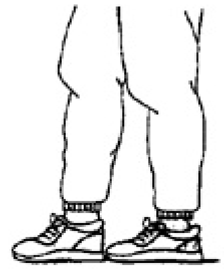
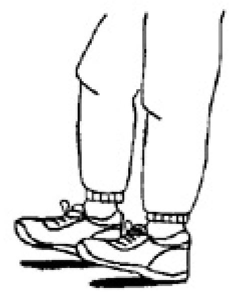
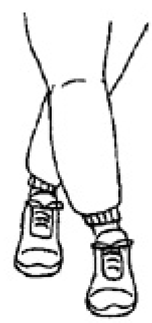
Participant Signature:

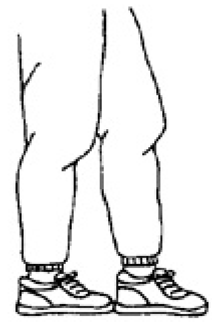
Signature of Witness:

Signature of Researcher:

APPENDIX-V-EXERCISE PROTOCOL

Toe Stand • Stand about one and a half feet away from the counter. • Raise up as high as possible on the balls of your feet. Your feet should be shoulder width apart. • Try to stay as still as possible. Do not move your feet around to maintain balance.	
Tandem Stand • Stand about one and a half feet away from the counter. • Place one foot directly in front of the other foot so that the heel of one foot is just touching the toes of the other foot. • Try to stay as still as possible. Do not move your feet around to maintain balance.	
Heel Stand • Stand about one and a half feet away from the counter. • Raise up as high as possible on the heels of your feet. Your feet should be shoulder width apart. • Try to stay as still as possible. Do not move your feet around to maintain balance.	
Toe Walk • Go to one end of a hall and slowly raise up as high as you can onto your toes. Walk down the hall on your toes. • When you reach the other side, come down onto your feet and stand normally.	

Tandem Forward Walk • Go to one end of a hall and place one foot in front of the other so that the heel of one foot touches the toes of the other foot. • Walk down the hall in a tandem walk. It is important that with each step the heel of one foot touches the toes of the other. If you make a mistake, just place one foot in front of the other and continue down the hall. • When you reach the other side stand normally.	
Heel Walk • Go to one end of a hall and slowly raise up as high as you can onto your heels. Walk down the hall on your heels. • When you reach the other side come down onto your feet and stand normally.	
Cross-over Walk • Go to one end of a hall and walk down the hall by placing one foot in front and on the other side of the other foot. Your feet are going in front and then sideways with each step, but your body continues to go straight. • When you reach the other side stand normally.	

Tandem Backward Walk	
Tandem Backward Walk • Go to one end of a hall and place one foot behind the other foot so that the heel of one foot touches the toes of the other foot. Walk down the hall in a backward tandem walk. It is important that with each step the toes on one foot touch the heel of the other. If you make a mistake, just place one foot behind the other and continue down the hall. • When you reach the other side, stand normally.	
PROGRESSION level 1. Use one hand to steady yourself as you perform the exercise. level 2.Use no hands unless you lose balance as you perform the exercise. level 3.Eyes closed and using no hands unless you lose balance as you perform the exercise.	

APPENDIX-VI-DATA PRESENTATION

sharpen Romberg test	Exp-pre	Exp-post	Con-pre	Con-post
1.	10.69	20.39	04.18	15.28
2.	16.90	40.12	25.05	34.25
3.	9.69	40.23	12.52	25.30
4.	7.22	25.01	06.05	18.20
5.	3.72	23.30	06.92	17.02
6.	16.20	30.36	04.59	15.71
7.	12.68	30.98	10.09	19.25
8.	14.40	35.38	12.85	28.92
9.	13.50	35.39	16.19	30.30
10.	18.16	45.20	18.25	35.21

Timed up and go dual task	Exp-pre	Exp-post	Con-pre	Con-post
1.	36.78	19.01	30.12	20.5
2.	25.10	13.32	44.32	33.21
3.	28.04	14.05	42.12	17.13
4.	22.50	14.12	35.12	19.34
5.	29.22	17.24	31.20	20.23
6.	20.50	14.25	25.25	19.3
7.	30.90	10.34	23.25	15.13
8.	45.80	12.26	26.25	20.2
9.	40.90	20.2	43.12	15.15
10.	38.89	16.3	32.35	22.32

Serial no. (single leg stance test)	Experimental group (eyes opened)		control group (eyes opened)	
	Rt pretest	Rt post test	Rt pretest	Rt post test
1.	05.07	15.97	03.16	08.28
2.	03.48	20.29	08.28	12.92
3.	04.15	25.02	07.28	15.32
4.	06.25	28.30	04.29	20.12
5.	02.78	32.42	06.18	18.29
6.	03.68	28.90	03.50	20.30
7.	04.60	32.50	08.23	22.25
8.	03.40	30.21	01.01	08.02
9.	06.38	23.92	02.02	10.23
10.	07.32	30.45	09.01	20.92

Serial no. (single leg stance test)	Experimental group (eyes opened)		Control group (eyes opened)	
	Lt pre test	Lt post test	Lt pretest	Lt post test
1.	10.46	25.09	02.94	10.39
2.	02.67	20.20	03.20	12.30
3.	03.63	23.12	07.41	15.48
4.	01.89	24.12	02.24	18.02
5.	02.58	30.12	03.20	19.30
6.	02.60	32.35	07.07	15.32
7.	05.10	33.52	06.63	18.32
8.	06.60	39.52	01.80	13.50
9	07.10	25.30	03.89	18.12
10.	06.90	35.50	08.12	25.20

Serial no. (single leg stance test)	Experimental group (eyes closed)		control group (eyes closed)	
	Rt pretest	Rt post test	Rt pretest	Rt post test
1.	01.28	22.38	02.31	13.15
2.	02.50	23.49	02.34	13.30
3.	01.91	22.30	05.13	13.50
4.	01.85	23.50	03.48	14.21
5.	02.10	25.09	04.31	14.99
6.	02.30	25.12	02.79	14.30
7.	03.20	25.42	05.50	15.01
8.	03.90	26.29	02.20	13.10
9.	04.12	28.12	01.25	12.35
10.	03.32	33.17	12.01	23.23

Serial no. (single leg stance test)	Experimental group (eyes closed)		Control group (eyes closed)	
	Lt pre test	Lt post test	Lt pretest	Lt post test
1.	01.20	22.48	01.50	12.20
2.	01.02	22.21	04.05	14.98
3.	01.79	22.20	03.23	13.29
4.	04.38	26.38	02.53	15.26
5.	01.18	24.68	02.20	13.12
6.	02.10	23.30	02.98	13.10
7.	02.90	33.17	02.92	13.20
8.	02.50	34.25	01.05	12.02
9	04.01	26.60	02.25	13.32
10.	01.08	35.12	03.12	15.20