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A STUDY TO COMPARE DOMINANT AND NON-DOMINANT LEG STANCE TIME BETWEEN DIABETIC NEUROPATHIC AND ASYMPTOMATIC ELDERLY SUBJECTS

T. Arthi* Ms.A.Rajarajeswari**
**MPT Neurosciences,Postgraduate Student, Sri Ramachandra College of Physiotherapy,Porur, Chennai.*
***MPT (PhD), Associate Professor,Sri Ramachandra College of Physiotherapy,Porur,Chennai.*

Abstract
*The dominant and non-dominant leg stance time of diabetic neuropathic and asymptomatic elderly male subjects is compared to decipher if there is a significant variation in stance time between both the groups since only a few studies have analyzed the difference in balance performance between contra lateral legs.**Methods:**Diabetic neuropathic patients are graded according to Valk[37] scoring scale. Subjects with normal BMI and those falling within the mild and moderate grades of diabetic neuropathy are included in the study. Only right-handed subjects are included in the study in both diabetic and non-diabetic groups. The right leg is considered as dominant leg and left leg as the non-dominant leg. Subjects are asked to balance on dominant leg first and then on the non-dominant leg. Uni pedal stance time is recorded.**Results:** There is a significant difference between dominant and non-dominant leg stance time in subjects with diabetic neuropathy and asymptomatic elderly adults. **Conclusions:***
From this study it can be inferred that diabetic neuropathy decreased the capacity of study subjects to stand on the single leg when compared with age, sex and BMI matched controls. Also, control group subjects were able to stand longer on their non-dominant leg, and as this was greatly reduced in diabetic neuropathic subjects it can be hypothesized that the impaired non-dominant limb balance could further augment their risk for falls. Hence it is suggested that exercise regime designed to improve balance could be emphasized on the non-dominant side.

Keywords: Diabetic Neuropathy, Dominant Leg, Non-Dominant Leg, Balance, One Leg Stance.

Introduction

Diabetic neuropathy is "the presence of symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after other causes''[3]. Peripheral neuropathies have been described in patients with primary (types 1 and 2) diabetes of diverse causes, suggesting a common etiologic mechanism based on chronic hyperglycemia.

Many people have significant deficits in tactile sensitivity, vibration sense,
Lower-limb proprioception and kinesthesia. The losses of sensation associated with diabetic peripheral neuropathy are thought to contribute to impaired balance, altered gait patterns and increased risk of falling[17].

Impaired balance in elderly leads to increased risk of falls. One leg standing test is a simple and reliable tool to measure static balance in clinical practice. One leg stance is used as an assessment tool, treatment method and as an outcome measure in neurological rehabilitation. When used as a treatment tool one leg stance is to be performed in both dominant and non-dominant leg but not many studies have recorded if there is a significant difference between the two sides.

Diabetic neuropathy is one common cause of balance disorder in elderly. By comparing one leg stance time between diabetic and control group subjects, this study aims to find the variation between the groups and to analyze if the preferred leg was more affected in diabetic neuropathic patients.

Lateralization refers to the development of lateral dominance (right or left eye, ear, hand, leg) and development of specialized centers and functions in the left and right brain hemispheres. The right side of the body sends messages to and is controlled by the left side of the brain and the left side of the body by the right side of the brain. Most people develop unilateral cerebral dominance –that is their dominant eye, ear, hand, and leg are on the same side of the body.[23]

Mark Hoffman 1998 in his study comments that an existing problem with the study of dominance is the lack of consensus in the definition and the determinants of limb dominance. In theory, limb dominance can be established based on strength, functional use, and personal preference, as well as other parameters. The literature is equivocal as to which parameter indicates dominance and how dominance can be determined.

While there is some debate about the definition of the dominant or preferred foot, most studies identify the dominant foot as the one employed to kick a ball (Poarc, Coren and Duncan 1980).

Research suggested that hand preference is somewhat related to foot preference and only weakly related to eye preference. Porac, Coren, and Duncan (1980) reviewed 113 published studies of lateral preferences and found that the percentages of right-sided foot preference ranged from about 85% of elementary school age children to slightly over 90% of the general adult population.

Right-handed people are most often also right legged.[34]

Balance is defined as the ability to maintain the center of body mass within the limits of stability primarily determined by the base of support.[12] Falls are to occur during loco motor activities such as walking, turning, backing up, descending stairs and negotiating obstacles. Fundamental to these locomotors activities is the transfer of weight from one foot to the other; brief periods of single limb stance are thus common to many activities of daily living.[1]

Unipedal stance is inherently a more challenging postural control task than bipedal stance; age and peripheral neuropathy affect both fall and Unipedal balance on a stable surface.[30] Single leg stance tests have been used as a predictor of falls since most falls occur during single leg stance activities.[26]

The one leg stance test is a measure of postural steadiness in a static position by a temporal measurement.[20]Unipedal stance time of less than 30 seconds in an older ambulatory outpatient is associated with a history of falling while a Unipedal stance time of more than or equal to30 seconds is associated with a low risk of falling.[17]

Although all older patients with peripheral neuropathy are at increased risk for falls, patients with increased BMI and more severe peripheral neuropathy are at particularly high risk and should be targeted for intervention.[30]

In this study diabetic neuropathy is defined as the presence of sensory and motor deficits in lower limbs caused exclusively as a complication of diabetes, in subjects with no other systemic disorder. As there are no accepted definitions for dominant and non-dominant leg, and many studies suggest that in right-handed person the right lower limb is more preferably used in tests of dominance for the lower limbs, in this study the right leg is considered as the dominant leg and the left leg as the non-dominant leg in right-handed individuals.

The dominant and non-dominant leg stance time of diabetic neuropathic and asymptomatic elderly male subjects, within the age group of 50-60 with similar BMI is compared to decipher, if there is a significant variation in stance time between both the groups, and within the groups, since only a few studies have analyzed the difference in balance performance between contralateral legs.

This study also aims to identify if the leg with lesser stance duration in diabetic neuropathic patients is the dominant leg as mentioned in a study done by Cimbiz A, Cakir O 2006,[6] which concludes that diabetic neuropathy disturbed the balance, especially on the dominant leg.

Studies suggest that a brief, specific exercise regimen improved clinical measures of balance like Unipedal stance time in patients with diabetic polyneuropathy.[33] Thus, by comparing dominant and non-dominant limb stance duration, the leg with reduced stance duration could be identified and exercises designed to improve balance could be emphasized on the side with reduced stance duration.

Methodology

The present study included 30 male patients diagnosed as diabetic neuropathic from the Diabetic Clinic, Sri Ramachandra University, Chennai. The control group consisted of 30 asymptomatic elderly male subjects, staff and attendees from Sri Ramachandra University, who were matched on all variables with the experimental group. Informed consent was taken from subjects before participating in the study. The present study followed an observational design. Purposive sampling was done to include study participants based on certain criteria.

Diabetic Neuropathic Patients

Inclusion criteria

1. Patients with mild to moderate grade diabetic neuropathy
2. Age group 50-60
3. Male subjects
4. Subjects with normal BMI

Exclusion criteria

1. Patients with diabetic foot ulcers
2. Patients with vestibular disorders
3. Lower limb amputations
4. History of major foot surgery
5. Patients who are unable to walk unaided

Normal healthy controls who matched the experimental group on all variables were selected for the present study.

Materials Required

1. Diabetic neuropathy grading is done by Valk[37] scoring system of clinical examination to assess diabetic neuropathy
2. BMI=WEIGHT (in kilograms)/HEIGHT (in meters) ² weighing scale to measure weight and wall mounted inch tape to measure height.
3. Stopwatch to measure stance time

Method

Diabetic neuropathic patients are graded according to Valk[37]scoring scale; weight and height are measured. Subjects with normal BMI and those falling within the mild and moderate grades of diabetic neuropathy are included in the study.

Only right-handed subjects are included in the study in both diabetic and nondiabetic groups. The right leg is considered as the dominant leg and the left leg as the non-dominant leg.

For Unipedal stance testing, patients are made to stand with their weight evenly distributed on both feet, which are shoulder-width apart, and arms held comfortably at the side. Subjects are then asked to balance on dominant foot by bending the other knee with the hip in a neutral position for as long as possible. Stance time is recorded. A failure occurred when the stance foot shifted in any way or the non-stance foot touched the ground.

The same procedure is then carried out with the non-dominant foot after a rest time of ten seconds. Subjects are made to stand with barefoot only. One practice trial is given before the start of the test to make the subject familiar with the test. Dominant and Non-dominant leg stance time of asymptomatic elderly subjects is recorded in a similar manner as it was done for diabetic neuropathic subjects.

Result

There is a significant difference between dominant and non-dominant leg stance time in subjects with diabetic neuropathy, in asymptomatic elderly adults and between the groups.

Discussion

The results of this study show that there is a significant difference in dominant and non-dominant leg stance time between diabetic neuropathic and asymptomatic elderly subjects. The groups considered for comparison were similar in age, sex, and BMI. They only differed in presence or absence of diabetes.

Subjects with diabetic neuropathy had greater difficulty in maintaining the Unipedal stance, their impaired balance and postural instability could be explained by the presence of neuropathy.

Presence of sensory and motor disturbances in diabetic neuropathic patients, as graded by the Valk scale, impaired their Unipedal stance. These findings are supported by studies done by Richardson JK 1996, Uccioli L et al 1997 and Hylton B.Menz et al 2004.

There are contrasting views on dominant and non-dominant limb balance available in the literature. Most of the studies were done on young adults in the field of sports, and post ankle injury patients to determine the difference in strength of contra lateral limbs.

Some studies found no difference in dominant and non-dominant limb balance,[24,25] in elderly greater sway was noticed with non-dominant foot, [12] and in diabetic neuropathic subjects, dominant limb balance was found to be more affected.[6]

In this study, it is seen that non-diabetic subjects have longer stance duration in their non-dominant leg i.e. they can balance themselves better on their non-dominant leg. Though diabetic neuropathic patients have reduced stance time on both dominant and non-dominant legs, it is seen that stance time is more reduced on the non-dominant leg i.e. they balance themselves lesser on their non-dominant leg.

Studies suggested that the left leg (non-dominant) and foot bear the weight and provide balance and coordination for the body when the right (dominant) leg is engaged in activities like kicking a ball, stepping up and/or down steps. Considering that the left (non-dominant) leg is the strong supporting leg,[28] and since non-dominant leg balance relate significantly to double-limb support stance,[42] it is hypothesized that the reduced stance duration of the non-dominant leg in diabetic neuropathic subjects could add to their balance impairment thus augmenting the risk of falls.

There are many studies supporting one leg stance test as a measure of balance in elderly and to identify peripheral neuropathy.[40,10,7] Though one leg stance test is to be performed in both dominant and non-dominant leg when used as a measure of assessing balance,[8] not many studies have documented if there are significant differences in stance time between the dominant and non-dominant leg.

In this study, it was found that there is a significant difference between dominant and non-dominant leg stance time in both diabetic and non-diabetic groups. The difference in stance time has *greater significance (99.9%) in subjects with diabetic neuropathy* than in the asymptomatic group.

Since this study shows that there is a significant difference between dominant and non-dominant leg stance time in both diabetic neuropathic and asymptomatic elderly subjects, the dominance of stance limb could be considered when assessing single leg balance.

In this study, the average stance time of diabetic neuropathic subjects in both dominant and non-dominant leg was less than 30 seconds. This increases their risk of falls as concluded by Hurvitz EA [15] et al 2001 in his study. Thus, reduced Unipedal stance time in diabetic neuropathic patients prove that they are at greater risk for falls and thus require early identification and intervention.

The reduced Unipedal stance time in diabetic neuropathic subjects could be due to both impaired sensory and motor functions and strength of ankle and foot muscles.[38] Thus balance training exercises could be emphasized in diabetic neuropathic subjects as studies suggest that an improvement in ankle strength and therefore muscle tension may also improve ankle proprioceptive thresholds.[33]

It also appears that muscle fascicle length could be influenced by physical training.[23] Training of one limb could alter the muscle thickness in that limb and exercises designed to improve ankle strength can be emphasized on the leg with reduce stance duration.

Thus, from this study, it can be inferred that diabetic neuropathy caused an impaired sensory function and decreased the strength of ankle musculature thus decreasing the capacity of study subjects to stand on the single leg when compared with age, sex and BMI matched controls. Since decreased single leg stance is related to greater falls as concluded in some studies, it can be said that diabetic neuropathic subjects are at greater risk for falls.

Also, control group subjects were able to stand longer on their non-dominant leg, and as this was greatly reduced in diabetic neuropathic subjects it can be hypothesized that the impaired non-dominant limb balance could further augment their risk for falls. Hence it is suggested that exercise regime designed to improve balance could be emphasized on the non-dominant side.

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Tables and Figures

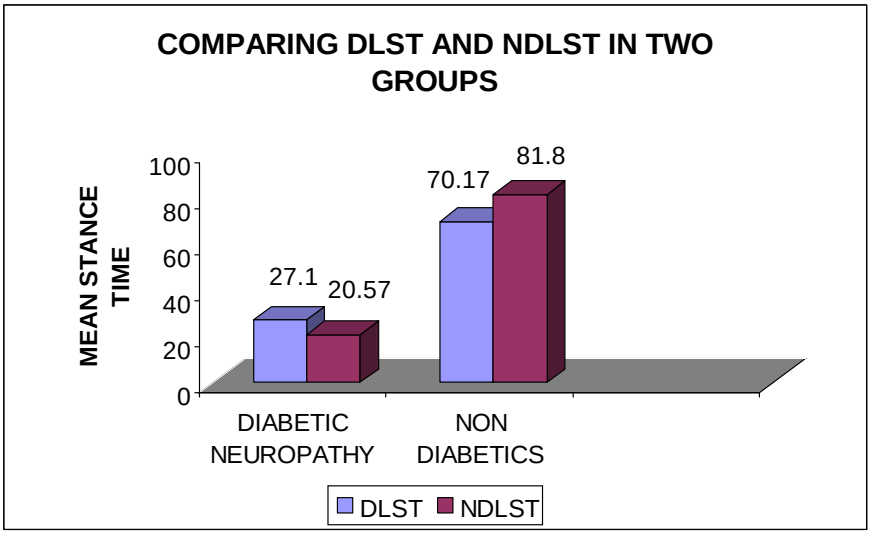
Results were analyzed using SPSS software version 11.5

Table 1

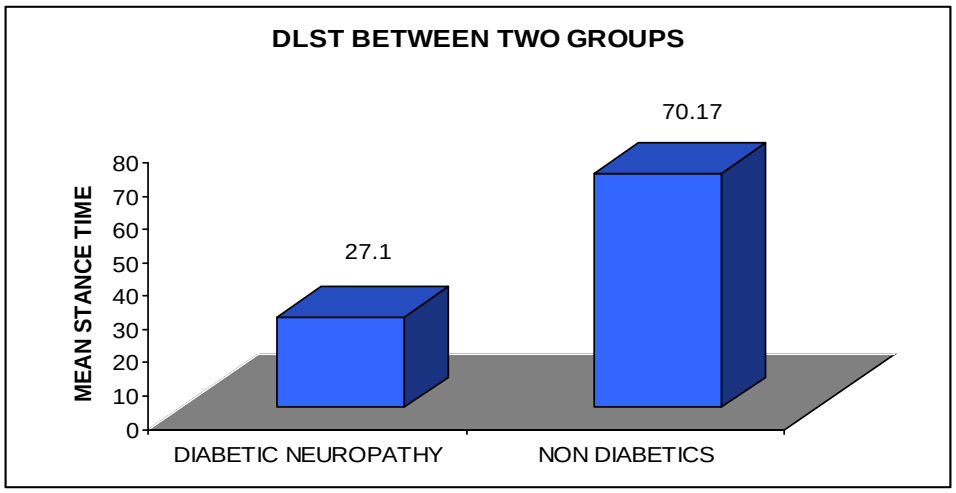
Groups	DLST		NDLST		p < 0.005
	Mean	Standard Deviation	Mean	Standard Deviation	
Diabetic Neuropathic	27.10	8.49	20.57	8.05	significant
Non Diabetic	70.17	20.23	81.80	24.20	significant

Table 1. Summarizes between-group analyses done using T-test.

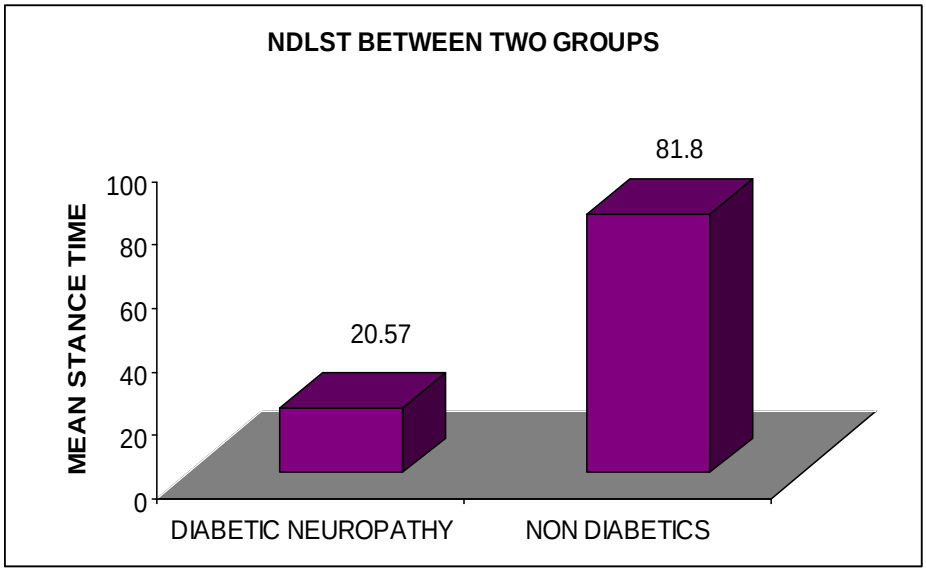
There is a significant difference (P<.001) in Dominant Limb Stance Time (DLST) and Non-Dominant Limb Stance Time (NDLST) between diabetic and nondiabetic groups.



DLST-Dominant Limb Stance Time
NDLST-Non Dominant Limb Stance Time



DLST-Dominant Limb Stance Time



NDLST-Non Dominant Limb Stance Time

Table 2 shows that the age and BMI of subjects included for the study are similar in both groups.

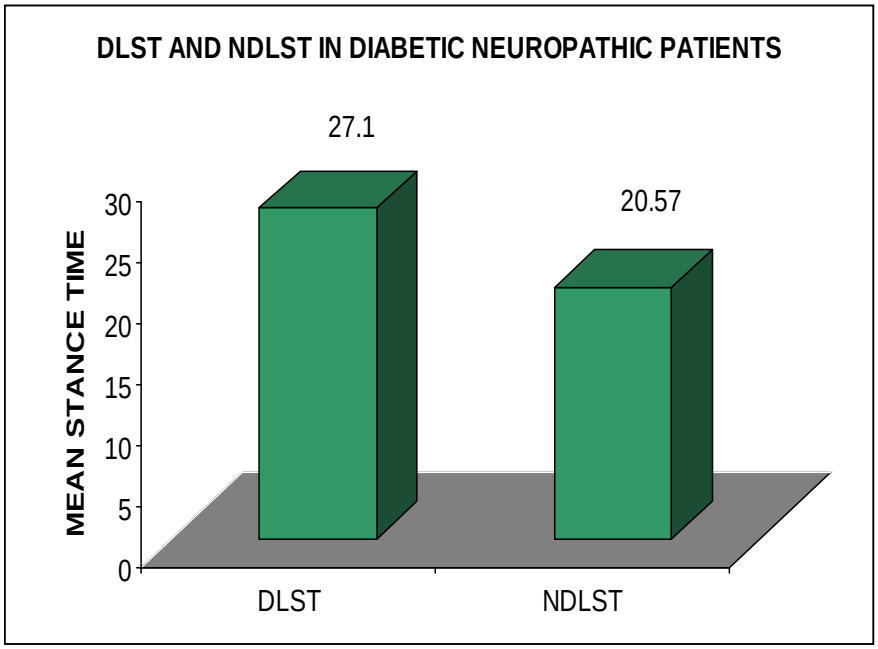
Group	N	Mean	Standard Deviation
Age			
Diabetic	30	54.57	3.84
Neuropathic	30	54.13	3.87
Non Diabetics			
Bmi			
Diabetic Neuropathic	30	22.7700	1.4919
Non Diabetics	30	23.2267	1.2043

Table 3.shows that in the diabetic neuropathic group the frequency of subject, distribution is similar in 50-55 and 56-60 age groups, while in non-diabetic group greater number of subjects are within the age group 50-55.

AGE	Diabetic Neuropathy		Non Diabetic	
	N	FREQUENCY	N	FREQENCY
50-55	16	53.3	22	73.3
56-60	14	46.6	8	26.6

Table 4 shows within-group analysis done for diabetic neuropathic subjects, there is a positive correlation (0.767) between DLST and NDLT i.e. as the DLST decreases NDLST also decreases. Also, the difference between DLST and NDLST in diabetic neuropathic subjects is significant (p<0.000).

Diabetic Neuropathic Group	Paired Correlation		Paired Significance	
	Correlation	P<.005	T	P<.005
DLST And Ndlst	.767	significant	6.321	significant



DLST-Dominant Limb Stance Time
NDLST-Non Dominant Limb Stance Time

Table 5- shows that the degree of involvement of dominant and non-dominant in diabetic neuropathic groups is similar as graded by the Valk scoring system. There was no significant difference between the two limbs regarding the severity of neuropathy.

Valk Grade	Mean	Standard Deviation	T	P>0.05
Dominant Limb	10.33	3.69	0.687	Not Significant
Non Dominant Limb	9.77	2.61	0.687	Not Significant

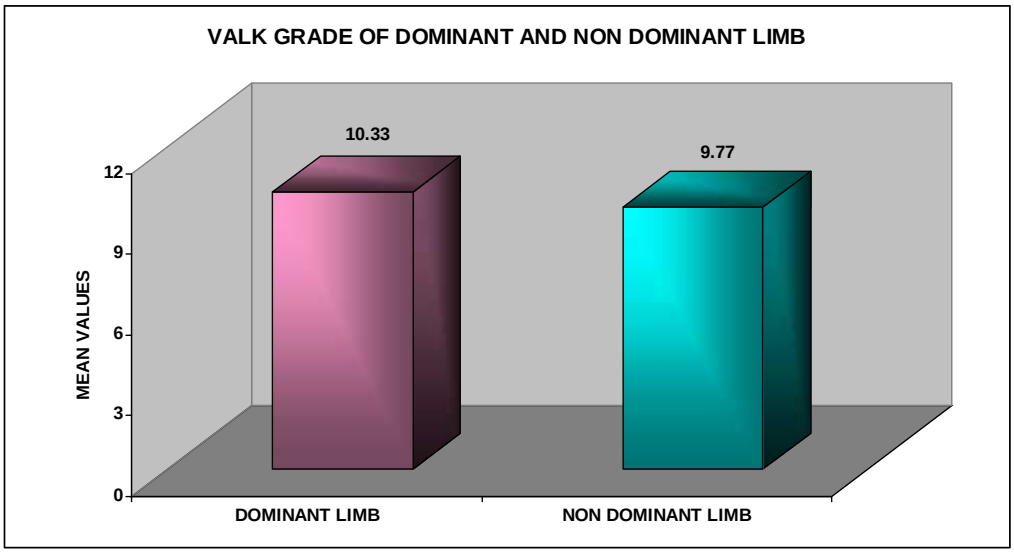


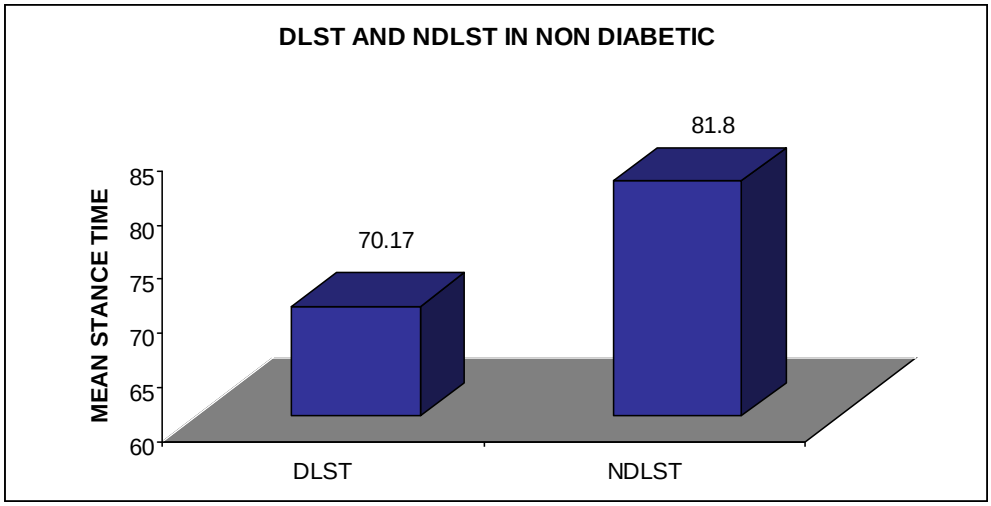
Table 6 shows that the distribution of diabetic neuropathic subjects with the mild and moderate involvement of dominant and non-dominant lower limbs were similar

Valkgrade	Frequency	Percent
DL Mild	15	50
Moderate	15	50
NDL Mild	12	40
Moderate	18	60

DL-DOMINANT LIMB
NDL-NON DOMINANT LIMB

Table 7-Table 7 shows within-group analysis done for nondiabetic subjects. There is a positive correlation (0.276) Between DLST and NDLST i.e. as DLST increases NDLT also increases. Also, the difference between DLST and NDLST in non-diabetic subjects is significant (p<0.25)

Nondiabetic Group	Paired Correlation		Paired Significance	
	Correlation	Significance	T	Significance
DLST and NDLST	.276	.140	2.367	.025



DLST-Dominant Limb Stance Time
NDLST-Non Dominant Limb Stance Time