

Original Article

Feasibility of Four Square Step Test (FSST) individual with diabetic neuropathy: a pilot study

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Abstract

Diabetic neuropathy (DN) is a prevalent complication of Type 2 Diabetic Mellitus (T2 DM) with a major impact on the health of the affected patient. The presence of DN may impair the balance in the affected patients. The study aimed to evaluate dynamic balance in patients with diabetic neuropathy by Four Square Step Test (FSST). This study is cross-sectional, with a sample size of 14 diabetic neuropathy patients (7 males, 7 females) with a mean age of 57.78±9.20 mean weight of 63.79±11.06. To evaluate dynamic balance in diabetic neuropathy patients, FSST (Four Square Step Test) was used. Descriptive statistics were used to measure mean±standard deviation for inter-rater & intra-rater reliability. Scale Cronbach's α correlation was used and statistics related to the Shapiro-Wilk test were used to estimate the normality of data. The results showed highly significant in both the intra-rater and inter-rater reliability, so the FSST scale was used to assess the dynamic balance. FSST has excellent intra-rater reliability and inter-rater reliability to check the dynamic balance of individuals with Diabetic Neuropathy. FSST is Feasible to check the dynamic balance.

Keywords: diabetes, feasibility studies, FSST, hyperesthesia, postural balance.

Introduction

Diabetes mellitus is the largest global public health problem of the 21st century. It is a chronic metabolic disease characterized by hyperglycemia resulting from a disturbance in insulin action, insulin secretion or both. In type 1 DM, T cell-mediated autoimmune attack leads to the loss of beta cells leading to insulin deficiency and resistance to insulin, causing type 2 DM. The high blood sugar level is associated with long-term complications affecting the heart, nerves, blood vessels, kidneys and eyes [1]. The worldwide prevalence of DM has risen dramatically over the past two decades, from an estimated 30 million cases in 1985 increased 415 million in 2017. According to data from the International Diabetic Federation and the WHO, type 2 DM is the largest and

most expansive disease. In 2040 this number will be increased to 642 million [2].

Diabetes is due to either the pancreas not producing enough insulin or the body's cells not responding properly to the insulin produced. The primary cause is excessive body weight and insufficient exercise [2]. There are several etiological factors of DM type 1 caused by immune-mediated, idiopathic and type 2 caused by a genetic defect of the beta cell function, genetic defect of insulin action (e.g., leprechauns, lipodystrophies), pancreatic disease. Excess endogenous production of hormonal antagonists to insulin, e.g., growth hormones acromegaly [2].

Diabetes is the chemical reaction by the product of sugar and proteins, irreversible cross-linked affected are called the AGE (advanced glycation end products).



People with Type 1 DM may also experience episodes of diabetic ketoacidosis, a type of metabolic problem characterized by nausea, vomiting and abdominal pain, the smell of acetone in the breath, and deep breathing exercise known as Kussmaul breathing [3]. Diabetic complication is characterized by increased blood glucose levels that affect insulin or give resistance to insulin action. Diabetes Neuropathy is one of the most common complications that affect 50% of patients. Neuropathy is characterized by damage to the nerve that affects the sensory and motor parts of the body [4].

Diabetic Neuropathy (DN) is a symmetrical, length-dependent sensorimotor polyneuropathy that develops on a background of longstanding hyperglycemia, associated derangement and cardiovascular risk factors. Diabetic neuropathies manifest in several different forms, including sensory, motor, and focal/multifocal symmetric polyneuropathy. Balance is one of the top three risk factors for falling, reduced quality of life that result in declining mobility, activities of daily living, avoidance of any activity and mortality in people with type 2 DM [5].

Balance is a complex skill that requires the integration of multiple sensorimotor and cognitive processes, and age-related deterioration in sensorimotor balance is a complex skill that requires the integration of multiple sensorimotor and cognitive processes, and age-related deterioration in sensorimotor as well as cognitive systems can disrupt the ability to maintain balance. Consequently, it may not be attributed solely to DPN, and knowledge of type 2 diabetes-related sensorimotor and cognitive deficits may help to broaden approaches to fall prevention in older adults with type 2 diabetes [2–6].

Falls are more common in type 2 DM in older adults, occurring over the age of 65, mainly in patients with poor glycemic control [5]. Balance affects both the physiological (strength and proprioception) and the cognitive-behavioral factors (fear of falls) when treating diabetic patients with gait impairment [7].

Various assessment tools are used to assess balance, like Berg Balance Scale (BBS) and the Time Up and Go test. However, no study describes the feasibility of the four-square-step test (FSST) in individuals with diabetic neuropathy. So, it is very important to assess dynamic balance with the help of the Four Square Step Test (FSST), i.e., not used previously in patients diagnosed with diabetic neuropathy. This study aims to determine the feasibility of the Four Square Step Test (FSST) in individuals with diabetic neuropathy. The Four Square Step Test (FSST) is the test to assess dynamic stability. This test requires an individual to step

forward, backward and sideways over obstacles in a particular sequence [8]. So it is necessary to know the effects of the use of FSST as a assessment tool to improve walking ability and its impact on the functional mobility of daily life [9].

The need of the study is to evaluate dynamic balance in older adults with diabetic neuropathy with the help of the Four Square Step Test (FSST). Various assessment tools are used to assess balance, like Berg Balance Scale (BBS) and the Time Up and Go test. However, no study describes the feasibility of the Four Square Step Test (FSST) in individuals with diabetic neuropathy.

The study aims to establish the feasibility of the Four Square Step Test (FSST) to assess dynamic balance in a patient with diabetic neuropathy.

To evaluate dynamic balance in older adults with diabetic neuropathy with the help of Four Square Step Test (FSST). Various assessment tools are used to assess balance, like Berg Balance Scale (BBS) and the Time Up and Go test. However, no study describes the feasibility of the Four Square Step Test (FSST) in individuals with diabetic neuropathy.

Material and methods

The cross-sectional study was conducted for 6 months on diabetic neuropathy subjects (n=14) who fulfilled the inclusion criteria at the tertiary care center in Haryana. Inclusion criteria were age between 45–65 years, having diabetes mellitus for more than 2 years and a Berg Balance score between 40–56. The subjects excluded were using an assistive device, having hypo or hypersensitivity, psychosomatic or any other neurological disorder, had recent lower limb injury or underwent lower limb surgery recently. The subjects were recruited based on selection criteria, and all the subjects gave their written consent form for the voluntary participants. The entire demographic characteristics and BMI of each subject were documented. Berg balance test of each and every patient was done. The score of every patient was calculated and the mean value of the Berg Balance test score was premeditated.

To evaluate dynamic balance in diabetic neuropathy patients, FSST (Four Square Step Test) was used. In FSST, four canes setup was done in cross-figure on the ground. At the beginning of the test, the subjects were standing in square one, facing square two. The goal was to move as fast as possible into each square in the sequence: square 2, 3, 4, 1; then 4, 3, and 2, 1 (clockwise to counter clockwise). The test procedure was

demonstrated, and one trial was allowed before doing the test for the subjects. Time started when the first foot touched the floor in square two and ended when the last foot reached the floor in square one. After each completion of the test procedure, the patient was provided with 30 sec of rest to eliminate any errors due to fatigue. Three readings of FSST were worked out and the mean of 3 readings was calculated. Instructions were given to complete the sequence as early as possible without touching the sticks. Both feet must make contact with the floor in each square. The trial must be repeated if the subject fails to complete the sequence, losses balance comes in contact with the cane.

Inter-rater and intra-rater reliability of FSST were assessed in this study. Three readings of FSST, i.e., FSST 1, FSST 2 and FSST 3 were taken for the purpose of intra-rater reliability i.e., the same rater (principal investigator) took three readings of FSST at different intervals of time. For inter-rater reliability, two raters have taken the readings at the same time. Interclass Coefficient and Cronbach's alpha assessed intra-rater reliability, while inter-rater reliability was assessed by Cronbach's alpha and Cohen's Kappa value.

of the data was conducted by using the Shapiro-Wilk test. As data ensures normal distribution, the descriptive statistics of FSST were shown with 95%CI, mean and standard deviations, as shown in Table 1. The intra-rater reliability of the scale, i.e., FSST 1 and FSST 2, and the intraclass correlation coefficient were used as shown in Table 2 and Figure 1. The inter-rater reliabil-

Table 1: Demographic data.

Variable	Mean±SD
Age	57.78±9.20
Height	160.86±11.31
Weight	63.79±11.06
BMI	24.69±3.976

Table 2: Intra-rater reliability measuring FSST 1 and FSST 2.

Scale	ICC	Cronbach's α	P-value
FSST 1	0.895	0.945	0.00
FSST 2	0.895	0.945	0.00

Results

The analysis was estimated in Statistical Package for Social Science (SPSS) version 20. The normality

ity of the scale, i.e., FSST 3 and FSST 3B, Pearson correlation was used as shown in Table 3 and Figure 2. The scatter plot was used to analyze the agreement between inter-rater reliability and intra-rater reliability.

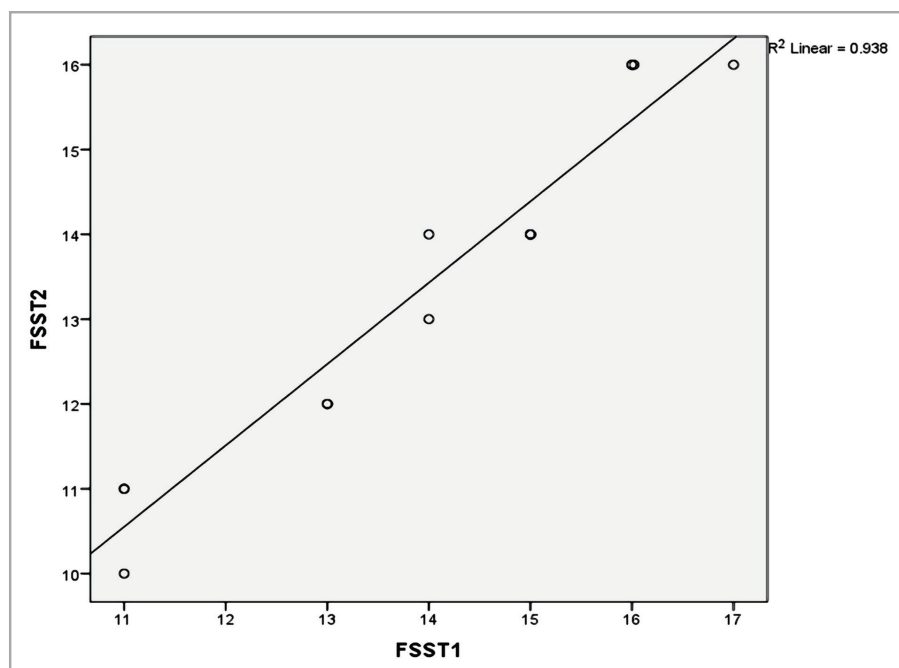


Figure 1: Scatter plot describing the reliability between two sessions by the same rater in measuring FSST 1 and FSST 2 with intraclass correlation coefficient. ICC=0.93 (0.92–0.99). ICC – Intra Class Correlation Coefficient; FSST – Four Square Step Test.

Table 3: Inter-rater reliability measuring FSST 3 and FSST 3B

Scale	ICC	Cronbach's α	P-value
FSST 3	0.969	0.984	0.00
FSST 3B	0.969	0.984	0.00

For both inter-rater & intra-rater reliability, the Scale Cronbach's α correlation was used.

Discussion

This study was conducted to determine the feasibility of FSST in diabetic neuropathy patients. Diabetes Mellitus is a metabolic disorder in which high blood sugar levels are present over a prolonged period. In chronic cases of diabetes mellitus, one can be affected with diabetic neuropathy, which affects balance that may increase the risk of fall in patients with the same.

A study conducted by Ijzerman concluded that muscle strength was reduced in both DM2 patients and that affected quality of life. The results of this study are carried out through intra class correlation coefficient (ICC), which says inter-reliability is highly significant (.984) and intra-reliability is moderately significant. This points out to the fact that FSST can be used to check the balance and coordination in the patients which will help in preventing any falls that causes in-

juries. Balance is an integral part in maintaining the quality of life. Thus, an early diagnosis followed by a proper intervention may help improve the prognosis in diabetic neuropathy patients [10]. Another literature concluded that grater separation of center of mass from center of pressure present a great challenge to balance. It was found that there was high medial separation found in patient with diabetic peripheral neuropathy and these contribute to high risk of fall [11].

In previous studies, not a single measurement was taken of balance for those at risk of falling due to its multifactorial nature. Keeping this in mind, FSST provides an antique measure of rapid step-taking in multiple directions, which can be used in combination with other outcome measures such as TUG. This provides a more clinically significant picture in every aspect for those leading to poor balance issues [8].

For intra-rater reliability, 2 evaluators calculated one is the principal investigator and the other, we obtained CCI (two-way random effects) ranging from 0.91 to 0.94. In Cronbach's alpha, the internal consistency of intra-rater reliability shows excellent measure ($\alpha \geq 0.93$). Whereas the Correlation Coefficient significance of intra-rater reliability in our study is p-value is $p=0.969$.

For inter-rater reliability, we procure ICC (two-way mixed effects) is 0.895 and in Cronbach's alpha internal consistency measure, it shows excellent value ($\alpha \geq 0.9$), and $p=0.945$.

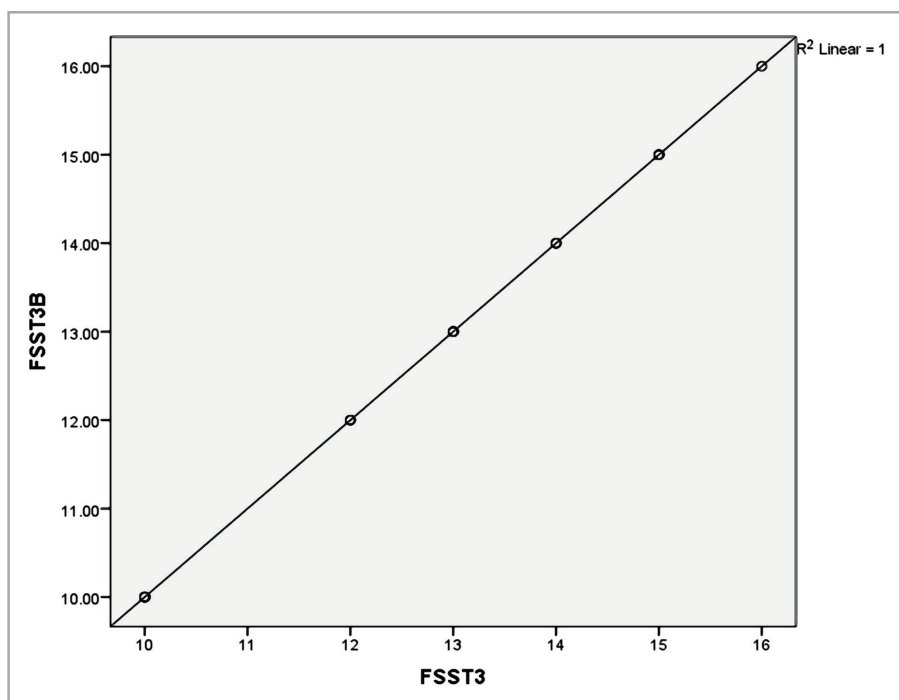


Figure 2: Scatter plot describing the association reliability between two sessions by two different raters in measuring FSST 3 & FSST 3B with intraclass correlation coefficient. ICC=1 (more than 0.90).

FSST showed excellent intra and inter-rater reliability in checking the dynamic balance of Diabetic Neuropathy patients. FSST is a less comprehensive balance measure tool. It can be used easily and economically in various settings with a simple four wooden cane and a timer machine to check dynamic balance.

The limitation of this study was the small sample size and single site for data collection. However, the study's strength was that FSST, a less comprehensive balance measure tool, can easily administer in any field setting. FSST required only <1 minute to measure dynamic balance. FSST does not require any other material.

The study can be continued with large sample size and concurrent validity can be calculated.

Conclusion

FSST is an innovative and potentially beneficial tool for quantitatively measuring dynamic balance, transition time and stability. The results of this study suggested that FSST has excellent intra-rater reliability and inter-rater reliability in checking the dynamic balance of individuals with Diabetic Neuropathy. It has been concluded that it is a reliable test to check the dynamic balance. FSST provides critical insight into stability, weight shifting, and weight acceptance that could guide interventions and further assessment for future studies.

Conflict of interest

The authors declare no conflict of interest.

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