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Postural Sway in Diabetic Neuropathy patients using Swaymeter

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ABSTRACT
Diabetic peripheral neuropathy is among the most common complication of diabetes mellitus and can be described as a demonstrable disorder of somatic and/or autonomic peripheral nerves leading to postural instability. Postural sway, a component of postural control can be measured using sway meter but inadequately addressed in diabetic neuropathy patients. To evaluate efficacy of sway meter for detecting postural sway in diabetic peripheral neuropathy patients and to found out the correlation between sway measurements obtained and the various methods used for the screening of the Diabetic peripheral neuropathy. The study included a total of 60 age matched subjects within 45-65 years, divided into three groups. Screening of neuropathy patients was done using Michigan Neuropathy Screening Instrument Questionnaire, 10-g Monofilament and 128-Hz Vibration tuning fork. Postural sway was measured using Lord's Sway meter during eyes open and eyes closed condition. The mean sway for diabetic peripheral neuropathy patients during eyes open was 1.954cm and 1.744cm whereas during eyes closed was 2.463cm and 2.113cm in anteroposterior and mediolateral direction respectively. Sway measurements obtained were significantly larger in the diabetic peripheral neuropathy group than in the diabetic and control group. Therefore sway meter can be used as a reliable tool for measuring postural sway in diabetic peripheral neuropathy patients.
Keywords: *Diabetic peripheral neuropathy, postural sway, sway meter.*

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INTRODUCTION
Postural stability or balance is to maintain body's Centre of mass over the limited base of support under the feet and is achieved by synkinesis of the limbs and body trunk based on information from postural adjustment function1. An irregularity in the postural sway is usual whenever there is a disturbance in any of sensory input and/or of the motor output is present2. One of the most important cause for decline in balance is considered as age and others includes various health or medical conditions such as stroke, paroxysmal positional vertigo, Parkinson's disease, multiple sclerosis, vestibular deficits, diabetes, peripheral neuropathy (PN), obesity and cerebral palsy3. Peripheral neuropathy is among the most common complication of diabetes and can be described as demonstrable disorders that are evident either clinically or sub clinically in diabetes mellitus. Although neuropathy is considered late complications but may be evident in the early course of diabetes5. Diabetic neuropathy encompass abnormalities of the somatic and/or autonomic peripheral nerves and accordingly classified as sensori-motor or autonomic, depending on signs and symptoms4. Screening of diabetic peripheral neuropathy patients can be done using a number of methods ranging from validated questionnaires such as MNSI, to quantitative methods such as vibration testing or clinical examinations such as ankle reflex, vibration sensation by tuning fork and pressure sensation by using 10 g Semmes-Weinstein Monofilament (SWM)7. During a double foot stance body sway could be measured using a sway meter, which was proposed by Lord et al in 1991. Later in 1996 Lord et al measured the variables of sway as maximum balance range using sway meter and concluded its test-retest reliability. Therefore Sway meter used by Lord is a reliable tool in evaluating and analyzing posture without the use of expensive equipment such as force platform and motion laboratories. But literature suggests that the influence of Diabetic Peripheral neuropathy on the balance has not been adequately addressed using Lord Sway meter.

MATERIAL AND METHODS
In this observational study, 60 subjects of age group 40 to 65 years who were already diagnosed by physician with Type 2 Diabetes and their age matched healthy individuals were included in the study. Study was done in various clinics of Delhi and NCR region. Subjects were explained about the aim and procedure of the study and inform consent were obtained from each subject. All the participants who

fulfill the inclusion criteria were included in the study and divided in three group i.e. Diabetic group, Diabetic peripheral neuropathy group and control group respectively.
Sway measurement were measured using sway meter. To remove any visual inputs sway meter was placed behind the subject. Foot prints were drawn on a sheet of paper and subjects were asked to remove their footwear and stand on it. The foot imprints used was constant for all individuals. They were instructed to stand as still as possible on foot marks and hands by their sides[2]. A total of six trials were done including, first three trials with eyes open and next three trails with eyes closed. Maximum duration recorded for all trials was 5-6 minutes including rest interval of 5-10 seconds in between the trials. The sway measurement included antero-posterior (AP) and mediolateral (ML) displacements which were maximum peak-to-peak displacement in the respective direction[1]. Comments from the subjects were obtained at the end of the procedure regarding the application and limitations in using the sway meter[2].

DATA ANALYSIS

Statistical analyses were performed using statistical package for social sciences (SPSS version 20.0 for Window) with statistical significance at $p \leq 0.05$. Means and SD were calculated for age, gender, duration of diabetes and each sway variables among three groups. Analysis of variance was performed to examine differences in sway measurements between-group and within group during eyes open and eyes closed in both directions. Post-hoc test was applied using Fisher's Least Significant Different (LSD) to identify significant differences in group comparisons. Paired t-test was used to analyze variation in two conditions among the same group. Also to find correlation between sway measurements and various screening methods used, Pearson correlation coefficients was used.

RESULT

A total of 60 subjects were studied including 40 Type-2 Diabetes Mellitus patients (20 diabetes patients without neuropathy and 20 diabetic peripheral neuropathy patients) and 20 age matched healthy individuals. All the subjects participated in the study successfully completed all trails without incident. The distribution of patients in three groups didn't differ significantly in relation to their age, gender and BMI (Table 1).
The data collected for sway in all groups was analyzed in both eyes open and eyes closed conditions. Sway measurements during eyes closed was significant increased ($p \leq 0.05$) as compared to eyes open in all groups(Illustrated in Figure 1, 2).MNSI questionnaire, 10-g Monofilament testing and Vibration sensation testing were found to be significantly correlated at $p \leq 0.05$ with sway measurement (Table 2).

DISCUSSION

This study concerned with evaluation of influence of diabetic peripheral neuropathy on postural sway using sway meter. The chief finding of this study was that diabetic peripheral neuropathy patients have significantly larger sway compared to either diabetic patients or age matched healthy individuals during quiet standing. Similar results were obtained in various studies done to evaluated postural stability in diabetic neuropathy patients[3,14-16,18]. Postural instability in diabetic neuropathy can be due to lack of appropriate proprioceptive feedback from lower extremity, slowness in peripheral sensory and motor pathways, reduced lower-extremity strength, central nervous system dysfunction and visual deficits[14,16,17]. On comparing the sway measurements of diabetic patients with healthy control subjects, it was found that there was no significant difference in the sway measurements[14,16]. These results conclude that diabetic per se has no effect on the postural sway. However, there are studies which states that there is a negative influence of diabetes on postural control system and peripheral neuropathy may not be the one and only cause for balance impairment in people with diabetes. In their study, diabetic patients required faster accelerations on force platforms in order to detect fairy translations in anterior directions. But these findings were significant only when the vision was occluded i.e. during eyes closed, suggesting greater risk of slip or fall in diabetic patients in low or no light[17]. As there was an overall increase in the sway during eyes closed condition but some individuals showed reduced sway during eyes closed compared to eyes open. These changes could be supported by stating that subjects were becoming more sensitive of their sway during eyes closed and making an effort to control it[2]. Sway in anteroposterior direction was more as compared to the mediolateral direction during eyes open and eyes closed condition among all groups. Helene Corriveau et al., found more of AP displacement than ML displacements in both diabetic neuropathy and control groups. Lafond et al., found the similar results in their study and stated that these measures could be due to activation of ankle strategy which involves slight intermittent contraction of ankle plantar flexors and dorsiflexors. Therefore during quite standing the sway is along the axis of rotation of the ankle joints[16]. Screening using MNSI questionnaire, 10-g Semmes-Weinstein Monofilament and vibration sensations testing method showed a significant positive correlation with the sway measurements, by which it can be interpreted that higher MNSI questionnaire score will have more sway measurements. Whereas a significantly negative correlation between 10-g SWME score and vibration sensation testing score with the sway variables concludes lesser the score in above two methods more will be the sway[6,7,9,10].To maintain balance during quiet standing, both the size and position of the base of support are important. In our study foot prints were constantly same for all subjects during the sway measurements. Feet were at a distance of 15 cm and an angle of 25^0 toe out position which was considered to be most stable among the other foot positions given by R. Kirby et al., in their study. They tested for the various foot positions which would significantly affect the standing balance[19]. No subjects in our study reported instability while standing on foot imprints. Rather they find it stable during standing. Comments were obtained from the subjects about discomfort regarding the application of sway meter. None of the subjects reported any discomfort with the application of sway meter on their waist.

LIMITAION OF THE STUDY

The sample size was small. Also the study was limited to age group (45-65) years. In this study only two variables of sway were measured but other variable such as Total sway, coordinated stability and voluntary sway can also be studied using sway meter in diabetic peripheral neuropathy patients. Also Sway measurement with different head positions such as head turn to left and right or head straight and head back to check effect of vestibular system in postural sway.

CONCLUSION

In the lights of the results of the study we conclude that there is significantly larger postural sway in diabetic peripheral neuropathy patients compared to diabetic patients and control group using sway meter. Therefore Sway meter can be used as a reliable tool for determining the effect of diabetic peripheral neuropathy on postural sway. Also sway measurements obtained were significantly correlated with the screening methods used for diabetic peripheral neuropathy patients, which further add on the effectiveness of the screening methods.

Table 1: Characteristics of the subjects included in the study.

Demographic	GROUP A (n=20)	GROUP B (n=20)	GROUP C (n=20)	Total (n=60)
Age (years)	55.3±6.47	57.05±6.3	56.85±5.44	56.4±6.03
Weight (Kg)	63.93±9.59	74.05±11.5	71.44±10.4	69.81±11.2
Height (cm)	162.8±6.1	166.3±7.92	167.6±7.97	165.58±7.54
Body Mass Index (Kg/m^2)	24.15±3.75	26.83±4.41	25.5±3.92	25.4±4.12
Duration of Diabetes (years)	6.7±1.8	13.8±4.79	0	6.83±6.38

Table 2: Pearson correlation coefficient (r) for sway measurements against the screening methods used.

Screening Method	Eyes Open		Eyes Closed	
	AP	ML	AP	ML
MNSI Questionnaire	r = 0.417	r = 0.671*	r = 0.641*	r = 0.444*
SWME Score	r = -0.539*	r = -0.508*	r = -0.537*	r = -0.502*
Vibration Sensation Testing	r = -0.520*	r = -0.476*	r = -0.601*	r = -0.249

Screening Method	Eyes Open		Eyes Closed	
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MNSI Questionnaire	r = 0.417	r = 0.671*	r = 0.641*	r = 0.444*
SWME Score	r = -0.539*	r = -0.508*	r = -0.537*	r = -0.502*
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Figure 1.Comparison of mean of sway in antero-posterior direction during eyes open and eyes closed condition in all groups.

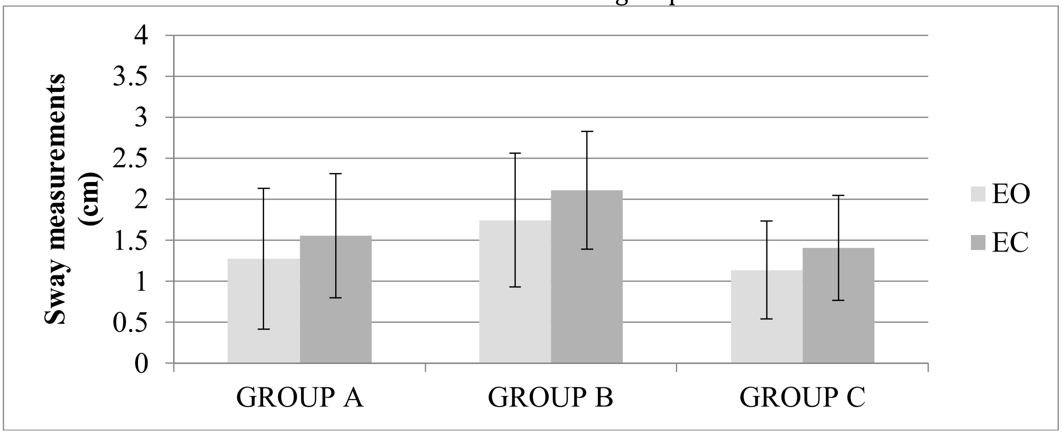
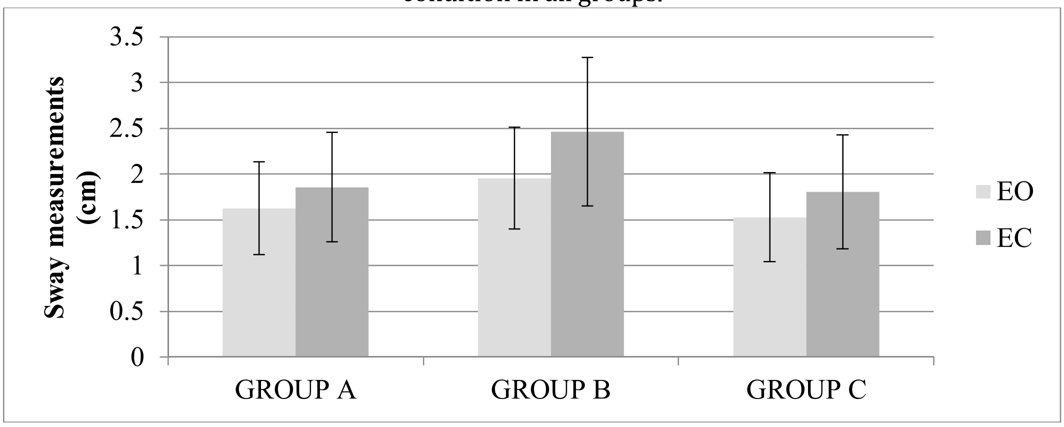


Figure 2.Comparison of mean of sway in mediolateral direction during eyes open and eyes closed condition in all groups.



CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest. The research received no specific grant from any funding agency in the public, community, or non-for profit sectors.

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