ORIGINAL ARTICLE

An Experience with the Use of Biothesiometer in Diabetics at a Tertiary Care Centre

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ABSTRACT

Aim: To assess early detection of peripheral diabetic neuropathy and its complications.
Type of study: Original observational pilot study.
Duration of study: the data was collected over a time frame of one year.
Setting: Study was done on diabetic patients presenting in medical OPD of Fatima Memorial Hospital.
Results: A total of 100 diabetic patients were included in the study, out of which 75 were females and 25 were male patients. The age range of these patients was 30-80 years with a mean of 51 years. The patients were divided into two groups >50 years and ≤ 50 years of age. The gender distribution was equal among both groups. Only 6% of patients reported to have numbness. Out of 100 patients, 21 patients had normal (15 volts) value, 35 had grade I (16-25volts) and 44 had grade II (>25 volts) on the biothesiometer machine.
Keywords: Neuropathy, Biothesiometer, Diabetes, vibration perception threshold (VPT)

INTRODUCTION

Diabetes mellitus is a metabolic disorder that has an impact on whole of the body sooner or later. Diabetic neuropathy affects 50% of the patients with longstanding diabetes mellitus. The duration of diabetes and glycemic control are correlated with the development of neuropathy. Diabetic neuropathy has different types, however the distal symmetrical neuropathy results in numbness which facilitates ulcer development[1]. There are different ways to detect peripheral diabetic neuropathy for example loss of ankle jerk, reduced vibration threshold, monofilament testing and biothesiometer.

The biothesiometer is an instrument which measures the threshold of appreciation of vibration sense. The amplitude of the stimulus (measured in volts) is gradually increased until the threshold of vibratory sensation is reached and the stimulus is appreciated by the patient. Patients with the threshold >25 volts (grade II) are at a high risk to develop ulcers later. Biothesiometer has 80% sensitivity and 98% specificity for detection of neuropathy[2].

METHODS

A total of 100 diabetic patients, both males and females, who presented in medical outpatient department were enrolled in the study. The study was conducted on digital biothesiometer vibrometer machine. The vibrometer had vibration frequency of 120 Hz and vibration output range of 0-50 volts. The dimensions of vibrometer were 4.3" H×7.9" w×11.5"and the weight of the machine with accessories was 3.5Kg. The results were recorded on a paper showing the neuropathy points on both right and left feet. Six points were checked on each foot on the plantar aspect; one on the plantar aspect of the big toe, three points at the metatarsals heads, one at the instep and one on the heel of each foot. The results were recorded in volts. All adult diabetics presenting in medical outpatient department and willing for the procedure were included in the study. Patients unwilling for the test, with ulcers and infection causing hindrance in test performance, with peripheral vascular disease and patients with vasculitis were excluded from the study.

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RESULTS

The study was conducted on 100 patients; out of which 75(75%) patients were females and 25 (25%) were males. The age range was between 30 and 80 years and mean age of the patients was 51 years. Only six (6%) patients gave history of numbness in feet and the rest of the patients (94%) did not tell about any abnormal sensations in their feet. Both categories showed equal distribution in two genders. When both right and left feet values were assessed on biothesiometer, the mean value for right and left foot was found to be 25.69 and 25.92 volts respectively when the minimum values for both feet was 15 and maximum was 50 volts.

Neuropathy was defined and categorized on the basis of grades. Twenty one patients (21%) who responded to a stimulus value of ≤15 volts were

considered to be normal. Thirty five patients (35%) could appreciate the stimulus of 16-25 volts and were classified as the group suffering from grade I neuropathy. The group of the patients whose threshold value was > 25 volts had grade II neuropathy. This group included 44 patients (44%).

The age distribution revealed that grade I neuropathy was more prevalent in patients ≤ 50 years of age (47.1%) than in those who were older than 50 years (22.4%). But grade II neuropathy was frequently seen in patients > 50 years (57.1% vs. 31.4%). The gender difference did not seem to affect the severity of neuropathy (Table 5)

Table 1: Descriptive statistics: age of the patients (n= 100)

Mean	51.00
Median	50.00
Mode	45.00
Std. Deviation	10.62
Minimum	30.00
Maximum	80.00

Table 2: Age Distribution of the patients

Age groups	Frequency	%age
≤ 50 years	51	51
> 50 years	49	49

Fig. 1: Histogram of the age of patients

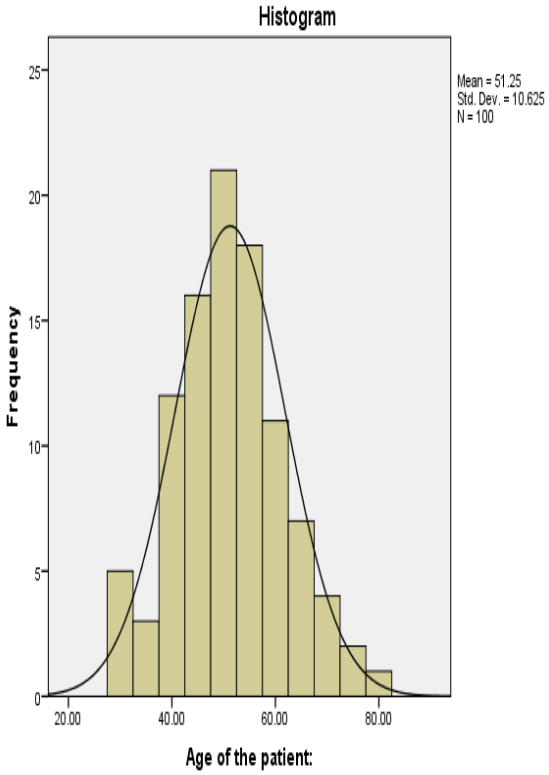

Fig.2: Distribution of patients according to gender.

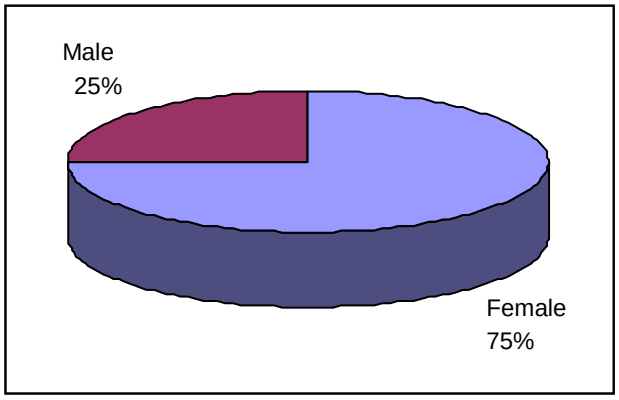

Fig. 3: Age distribution according to gender

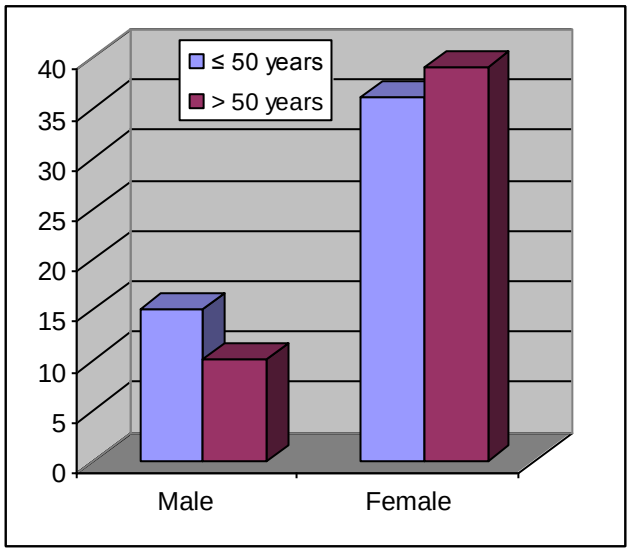

Table 3: Frequency Distribution of Neuropathy Grades

Neuropathy grades	Frequency	%age
Normal (up to 15 volts)	21	21
Grade I (16-25 volts)	35	35
Grade II (> 25 volts)	44	44

Table 4: Distribution of Neuropathy grades according to age groups

Neuropathy grade	≤50 years	>50 years	Total
Normal (up to 15)	11(21.6%)	10(20.4%)	21(21%)
Grade I (16-25)	24(47.1%)	11(22.4%)	35(35%)
Grade II (> 25)	16(31.4%)	28(57.1%)	44(44%)

Table 5: Distribution of Neuropathy grades according to gender

	Female	Male	Total
Normal(up to 15 volts)	18 (24%)	3 (12%)	21%
Grade I (16-25 volts)	24 (32%)	11(44%)	35%
Grade II (> 25 volts)	33 (44%)	11(44%)	44%

Table 6: Descriptive Statistics of Right and Left foot values

Statistics	Right foot average	Left foot average
Mean	25.69	25.92
Mode	15.00	15.00
Std. Deviation	8.91	8.90
Minimum	15.00	15.00
Maximum	50.00	50.00

Table 7: Gender wise descriptive statistics of right and left foot values

Stimulus (in volts)	Female	Male
Right foot	75	25
Mean	24.85	28.22
Mode	15	20
Std. Deviation	8.04	10.94
Minimum	15	15
Maximum	40	50
Left foot	75	25
Mean	25.04	28.54
Mode	15	20
Std. Deviation	8.08	10.76
Minimum	15	15
Maximum	40	50

DISCUSSION

Diabetes mellitus is like an epidemic in the world. Lower extremity amputations secondary to diabetic foot after long standing diabetic neuropathy affects 30 % of type II diabetics.[3] The annual population based incidence of foot ulceration ranges from 1.0-4.1% and the prevalence ranges from 4-10% in diabetics which indicates that lifetime incidence may be as high as 25 %[4].

Neuropathy is an important long term sequel to diabetes mellitus. Overall it affects 50% of longstanding diabetics[5]. Shera et al observed that the prevalence of neuropathy in type 2 diabetes is 39.6 % in Pakistani patients[6].

Basit et al studied 2199 type II diabetics which showed that the prevalence of diabetic foot ulcers was 10.4% and higher among males[7]. The incidence of diabetes in Pakistan is stated to be between 5-7%; taking into account that the incidence of foot ulcer is 10% as per studies by Basit et al we may have around one million (recalculated for 20 crore population) patients with diabetic foot ulcers[8]. Furthermore, the amputation mortality is stated to be 30 % within one year and increases to 50% in three years and 70% in five years[9].

Diabetic neuropathy has different types affecting the peripheral and autonomic nervous systems, both. Distal symmetrical polyneuropathy, painful diabetic neuropathy, mononeuropathy, mononeuritis multiplex and autonomic neuropathy are the different varieties of diabetic neuropathy. Diabetic neuropathy is directly related to the duration and severity of diabetes. Three different pathogenic mechanisms contribute to development of diabetic neuropathy; polyol pathway, microvascular damage and accumulation of advanced glycosylation end product accumulation[10]. Reduction in neurotrophic factors such as nerve growth factors neurotrophin-3 or insulin like growth factors is also a contributory factor.

Distal symmetrical polyneuropathy is the most common type and accounts for 75% of diabetic neuropathies. Patients present with hyperaesthesia, paresthesiaor dysaesthesia of feet and on examination there is impairment of vibration, joint position, touch and pressure sensations along with loss of ankle reflex. A clinical hammer, tuning fork of 128 Hz frequency and Semmes Weinstein 10 G monofilament are all used as bedside instruments to detect presence of neuropathy. However these tests require proper technique and keen observation, and completely depend on the expertise of the examiner.

The role of different bedside methods in evaluation of peripheral neuropathy was evaluated by Jayaprakash et al in a patient group of 1044 and found fluctuant sensitivity and specificity among different beside methods of neuropathy evaluation[11].

In our study the patients sample size was one hundred. Only six patients gave history of numbness and 94 patients did not complain of any symptom suggestive of sensory neuropathy. However when they were examined by biothesiometer, 79 patients (including all six who gave history of numbness) showed evidence of sensory neuropathy of grade I or II. Twenty one patients did not have any evidence of sensory neuropathy when assessed by biothesiometer. This shows that biothesiometer can detect sensory neuropathy even if the patients do not have any symptoms of neuropathy. The sample size of our patients was small but it was a pilot study to see the presence of neuropathy in patients and to educate them regarding foot care.

Biothesiometer is a device which can quantify and pick early cases of diabetic peripheral neuropathy. It works on the principle of an electrical tuning fork. It has a vibrating probe which when applied to the plantar aspect of feet detects neuropathy. The vibration amplitude is measured in volts and can be changed by turning the dial. The person being tested indicates as soon as the vibration is felt. The reading is low in young normal individuals. It means they are sensitive to vibration. As the individual gets older biothesiometer reading becomes progressively higher and hence the chances of developing ulcers are increased. The delayed healing and non healing ulcers can end up in amputations and hence increased mortality.

CONCLUSION

VPT is considered as a gold standard for the diagnosis of diabetic neuropathy. There is paucity of data on measuring VPT in diabetics by using biothesiometer in our country. The biothesiometer is an important device which detects peripheral neuropathy and grades its severity. The other bedside methods are simple and convenient but their results may be biased by subjective variation. Hence biothesiometer may be used to predict future development of neuropathic foot ulcers and chances of amputations may be reduced.

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