

RESEARCH ARTICLE

Perception of vibration threshold is a marker of diabetic neuropathy

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Received: May 04, 2017; Accepted: May 26, 2017

ABSTRACT

Background: Diabetes mellitus is a chronic progressive disorder and is concerned because of its devastating complications. Among this, nervous system is most frequently affected. Symptom varies widely in peripheral neuropathy due to diabetes. In majority of cases, sensory symptoms predominate. Vibration perception threshold (VPT) has added much to early diagnosis of peripheral neuropathy. The previous studies showed that, in mild-to-moderate diabetic neuropathy, VPT serves as excellent tool. **Aims and Objectives:** This study is planned to assess if VPT testing can be applied as early diagnostic tool in diabetic neuropathy. **Materials and Methods:** The studies on VPT were conducted in the Department of Physiology with the help of Department of Medicine at VIMSAR, Burla, within the time period of February 2015-November 2015. Vibration sense was detected in 60 diabetic patients, of which 30 had clinical neuropathy and 30 without clinical neuropathy. Chi-square test has been applied between parameters. The instrument used was Vibrotherm Dx. **Results:** In these 60 diabetic patients, VPT was conducted. This study shows the diverse result of VPT testing. Among the clinical neuropathy patients, 26.66% had Grade I severity and 43.33% had Grade II severity. It was found that in diabetic patients without the clinical neuropathy 50% had Grade I severity and 6.66% had Grade II severity. Hence, it was confirmed that nerve fibers are affected in subclinical states without any symptom. **Conclusion:** All diabetic patients irrespective of their clinical symptoms of neuropathy should be assessed by VPT testing. It will help to identify at risk group with diabetic peripheral neuropathy by detecting their VPT. It is also a cost-effective procedure. We can also prevent the devastating diabetic foot complications.

KEY WORDS: Vibration Perception Threshold; Diabetes Mellitus; Diabetic Neuropathy; Diabetic Foot

INTRODUCTION

Diabetes mellitus (DM) is a heterogeneous group of disease, characterized by a state of chronic hyperglycemia, resulting from a diversity of etiologies, genetic, and environmental factors acting jointly. The underlying cause of diabetes is the impaired production or action of insulin, a hormone

that controls glucose, fat, and amino acids metabolism. Two broad categories of diabetes are designated as type 1 and type 2 DM. Type 1 diabetes is the result of complete or near total insulin deficiency. Type 2 DM is a heterogeneous group of disorder characterized by a variable degree of insulin resistance, impaired insulin secretion and increased glucose production, and abnormal fat metabolism. Type 2 DM is more common than type 1 DM. The number of people with diabetes has risen from 108 million in 1980 to 422 million in 2014.^[1] The global prevalence of diabetes among adults over 18 years of age has risen from 4.7% in 1980 to 8.5% in 2014.^[1] Diabetes prevalence has been rising more rapidly in the middle- and low-income countries.^[1] The number of people with type 2 DM is increasing in every country.^[2]

Access this article online	
Website: www.njppp.com	Quick Response code 
DOI: 10.5455/njppp.2017.7.0518326052017	

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The WHO predicts that developing countries will bear the burden of this epidemic in the 21st century. India is called the diabetic capital of the world. Type 2 DM in Indians is being increasingly seen in younger and less obese persons than in western countries. The WHO projects that diabetes will be the 7th leading cause of death in 2030.^[1]

DM is a multisystem disorder; the nervous system is most frequently affected. Diabetic polyneuropathy is one of the most common long-term complications of diabetes affecting 50% of all diabetic people.^[3] Diabetes affects both myelinated and unmyelinated nerve fibers. Clinical symptom varies widely in peripheral neuropathy due to diabetes. In majority of cases, sensory symptoms predominate. Distal symmetrical neuropathy is the most common accounting for 75% of diabetic peripheral neuropathy (DPN).^[4]

The International Neuropathy Guidelines define DPN as the presence of symptoms and/or signs of peripheral nerve dysfunction in patients with diabetes after exclusion of other causes. This condition affects 30-50% of the patient population with diabetes, and this prevalence tends to increase proportionally with the duration of diabetes.^[5] Neuropathy often presents with a loss of protective sensation, defined as a level of sensory deficit, where a patient can sustain an injury without recognizing any inciting trauma.^[6] The progression from minor injury into ulceration, and ultimately evolution into a non-healing wound with underlying infection has been documented as the most common series of events preceding lower extremity amputation.

Invariably, diabetic neuropathy is a critical independent risk factor for foot ulceration and lower extremity amputation.^[7] Results from the diabetes control and complications trial showed that strict glucose control reduces the development of neuropathy in patients with type 1 diabetes. Vibration perception threshold (VPT) has added much to early diagnosis of peripheral neuropathy. The previous studies showed that, in mild-to-moderate diabetic neuropathy, VPT serves as excellent tool.^[8] VPT evaluates affection of peripheral nerve in a quantifiable manner.^[9] VPT testing had been done by many authors.^[8-10] No study has been reported in Western Odisha. Hence, this study is done to assess if VPT testing can be applied as an early diagnostic tool in diabetic neuropathy in patients of Western Odisha.

MATERIALS AND METHODS

The studies on VPT were conducted in the Department of Physiology with the help of Department of Medicine at Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Sambalpur, Odisha, within the time period of February 2015-November 2015.

Patients with DM according to the American Diabetes Association (ADA) criteria and who had at least two visits

in the past 6 months were included consecutively in the study. The institutional ethics committee approved the study protocol. An informed written consent was obtained from the study participants. A detailed history regarding the type, duration, and treatment of diabetes was recorded. The patients with a medical history of hypothyroidism, chronic renal failure, congestive cardiac failure, hepatic disorder, and complicated DM were excluded from the study.

A total of 60 diabetic patients were examined for DPN, of which 30 had clinical neuropathy and 30 without clinical neuropathy. To differentiate diabetic with clinical neuropathy and without clinical neuropathy, the Michigan Neuropathic Diabetic Scoring (MNDS) was done. The scoring range is 0-8, based on evaluation of 4 factors in each leg: (i) Appearance of foot (dry skin, fissure, infection, and deformities); (ii) presence of ulcer; (iii) achilles tendon reflex; and (iv) vibration perception in the great toe (measured by 128 Hz tuning fork).

VPT was measured with a biothesiometer - Vibrometer-VPT® (Diabetic Foot Care, Madras Engineering Service, India) in a standardized fashion by a single observer. The biothesiometer probe, which vibrates at amplitude proportional to the square of the applied voltage, was applied perpendicular to the test site with a constant and firm pressure. The study was carried out as per Saha et al., at an average 6 points in both feet great toe, 1st metatarsal, 3rd metatarsal, 3rd and 5th metatarsal, instep, and heel (Figure 1).^[11] The first probe was applied to patients hand to explain the feel of vibration early. Then patient is asked to concentrate on feet and to tell as soon as he starts feeling the vibration, and the value is noted. Vibratory sense was detected in 60 diabetic patients, of which 30 had clinical neuropathy and 30 had without clinical neuropathy. During recording, the voltage was increased from 0 to 50 V. The grading is:

Normal ≤ 15 V

Grade I - 16-25 V

Grade II > 25 V

Chi-square test has been applied between parameters.

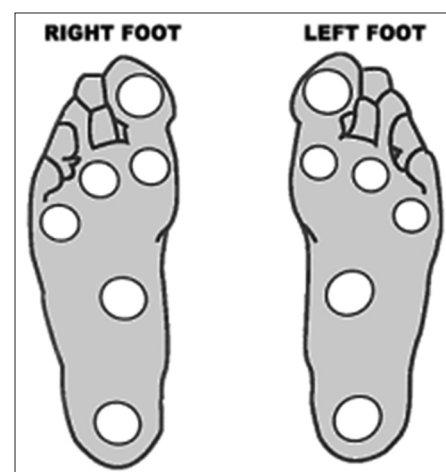


Figure 1: The sites of application of the biothesiometer probe

RESULT

Characteristics of the study population were described in Table 1, and Table 2 shows the distribution of biochemical parameters in two groups. There is no significant difference between the two groups regarding fasting blood glucose, post-prandial blood glucose, hemoglobin A1c level. According to Table 3, patient with clinical neuropathy, 70.1% had abnormal VPT and 26.66% and 43.33% show Grade I and Grade II severity, whereas 30% had normal VPT. Interestingly, even diabetic patient without clinical neuropathy, 56.66% had abnormal VPT and 50.00% and 6.66% show Grade I and Grade II severity. Whereas 43.33% had normal VPT. Taking into consideration of two groups of patients with clinical neuropathy and without clinical neuropathy, Chi-square test is performed. It is observed that $\chi^2 = 1.4$ ($P > 0.05$), i.e., no significant difference between the symptomatic and asymptomatic cases (Table 4).

DISCUSSION

The history and physical examination provides essential information for detecting peripheral neuropathy. Typically, the early symptoms of DPN include the gradual loss of sensation and/or development of pain. Other neurological symptoms, such as paresthesia, burning, or an aching sensation, may be secondary to DPN or nerve compression.

In these 60 diabetic patients were taken into consideration, of which 30 have clinical neuropathy and 30 have without clinical neuropathy. VPT testing was done in all the patients. VPT with a biothesiometer is a validated screening method in a population where foot care practices are scantily followed by the diabetes patients.^[12]

This study shows the diverse result of VPT testing. About 70.1% of patients with clinical neuropathy show positive VPT testing, but 30% do not have abnormal VPT. Similar finding also has been reported.^[13] The reason may be that VPT testing is more subjective in nature. Among the clinical neuropathy patients, 26.6% had Grade I severity and 43.33% had Grade II severity. This may be due to variable duration illness and the variable glycemic control value.

It was found that in diabetic patients without the clinical neuropathy 50% had Grade I severity and 6.66% had Grade II severity. Hence, it was confirmed that nerve fibers are affected in subclinical states without any symptom. It was found that up to 50% of DPN may be asymptomatic and patients are at risk of insensate injury to their feet. As 80% of amputations follow a foot ulcer or injury, early recognition of at risk individuals, provision of education, and appropriate foot care may result in a reduced incidence of ulceration and consequently amputation.^[14] Therefore, every diabetic patient should be assessed by VPT testing to find the probability

Table 1: Characteristics of the study population (n=60)

Characteristics	Mean±SD
Age (years)	52.6±12.5
Sex (M:F)	34:26
Duration (years)	7.2±5.9
BMI (kg/m ²)	25.14±4.19

SD: Standard deviation, BMI: Body mass index

Table 2: Biochemical parameters of the sample

Parameters	Clinical neuropathy	Non-clinical neuropathy	P value
FBG (mg/dl)	178.53±64.92	176.62±52.81	>0.05
PPBG (mg/dl)	270.63±73.62	260.53±68.72	>0.05
HbA1C (%)	7.73±0.051	7.51±0.23	>0.05

FBG: Fasting blood glucose, PPBG: Post-prandial blood glucose, HbA1C: Hemoglobin A1c

Table 3: Study of VPT

Severity of grade	Clinical neuropathy (n=30)	Non-clinical neuropathy (n=30)
Normal	9	13
Grade I	8	15
Grade II	13	2

VPT: Vibration perception threshold

Table 4: Diagnostic accuracy of MNDS scoring compared to VPT

Parameters	MNDS score
Sensitivity (%)	85.3
Specificity (%)	51.2
PPV (%)	80.1
NPV (%)	13.8

MNDS: Michigan Neuropathic Diabetic Scoring, VPT: Vibration perception threshold, PPV: Positive predictive value, NPV: Negative predictive value

of developing neuropathy. Van Deursen et al. stated that VPT testing serves as excellent reliability and serves as an appropriate screening tool to identify mild-to-moderate diabetic neuropathy.^[15]

There is a good correlation of VPT score with DNS score, tuning fork testing, monofilament testing, and ankle reflex testing. The MNDS score is simple clinical score useful to diagnose peripheral neuropathy in patients with diabetes. In this study, the symptom score was sensitive but was not specific for making the diagnosis of neuropathy. This is similar to the study by Jayprakash et al.^[16] Another study showed a sensitivity of 79% and specificity of 78% for DNS score as compared to VPT.^[17] However, both these scores are more subjective which may result in variability of these indices.

The use of VPT for the diagnosis of neuropathy has been well validated by clinical studies with a sensitivity and specificity of 80 and 98%, respectively.^[18] This is further substantiated by large epidemiological prospective studies showing that a VPT more than 25 mV had a sensitivity of 83%, a specificity of 63%, a positive likelihood ratio of 2.2 (95% confidence interval [CI], 1.8-2.5), and a negative likelihood ratio of 0.27 (95% CI, 0.14-0.48) for predicting a foot ulceration over 4 years.^[19] Since peripheral sensory neuropathy is a pivotal element in the causal pathway to both foot ulceration and amputation, selecting a quick, inexpensive, and accurate instrument to evaluate the high-risk patient is essential to make decisions.

Screening and early identification of neuropathy help to modify the course of glycemic control to currently recommended targets and to follow better foot care before the onset of significant morbidity. Reduced incidence of amputation and ulceration is seen after proper screening strategies, and screening for neuropathy is recommended in clinical practice guidelines.^[20] It may be advocated that, in subclinical cases of neuropathy, therapy should be instituted on the basis of VPT abnormality.

CONCLUSION

From this study, we can conclude that all diabetic patients irrespective of their clinical symptoms of neuropathy should be assessed by VPT testing. It will help to identify at risk group with DPN by detecting their VPT. If individual with reduced vibration could be identified, we can prevent long-term complication of foot ulcer; (ii) improve their health outcomes by preventing amputation; and (iii) reduce the treatment cost.

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How to cite this article: Dash S, Thakur AK. Perception of vibration threshold is a marker of diabetic neuropathy. *Natl J Physiol Pharm Pharmacol* 2017;7(9):1003-1006.

Source of Support: Nil, **Conflict of Interest:** None declared.