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Hidden dangers revealed by misdiagnosed diabetic neuropathy: A comparison of simple clinical tests for the screening of vibration perception threshold at primary care level

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ABSTRACT

Aim: Diabetic peripheral neuropathy is an important complication and contributes to the morbidity of diabetes mellitus. Evidence indicates early detection of diabetic peripheral neuropathy results in fewer foot ulcers and amputations. The aim of this study was to compare different screening modalities in the detection of diabetic peripheral neuropathy in a primary care setting.

Method: A prospective non-experimental comparative multi-centre cross sectional study was conducted in various Primary Health Centres. One hundred participants living with Type 2 diabetes for at least 10 years were recruited using a convenience sampling method. The Vibratip, 128 Hz tuning fork and neurothesiometer were compared in the detection of vibration perception.

Results: This study showed different results of diabetic peripheral neuropathy screening tests, even in the same group of participants. This study has shown that the percentage of participants who did not perceive vibrations was highest when using the VibraTip (28.5%). This was followed by the neurothesiometer (21%) and the 128 Hz tuning fork (12%) ($p < 0.001$).

Conclusion: Correct diagnosis and treatment of neuropathy in patients with diabetes is crucial. This study demonstrates that some instruments are more sensitive to vibration perception than others. We recommend that different modalities should be used in patients with diabetes and when results do not concur, further neurological evaluation should be performed. This would significantly reduce the proportion of patients with diabetes who would be falsely identified as having no peripheral neuropathy and subsequently denied the benefit of beneficial and effective secondary risk factor control.

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1. Introduction

Diabetic peripheral neuropathy [DPN] is a common complication of diabetes mellitus, which is known to affect approximately 50% of this population [1]. Patients usually develop a distal symmetrical form of neuropathy that follows a fibre-length-dependent pattern, mainly affecting the sensory and autonomic nervous systems. This condition is usually established after 50 years of age, especially in patients living with long-standing diabetes [2]. Diabetic peripheral neuropathy is considered to be a serious complication of diabetes, since it is one of the major risk factors for ulceration and amputation [3]. The exact pathophysiology of neuropathy and how nerve damage occurs is unknown, however, there are a number of theories which provide a possible explanation as to what happens on a molecular level to bring about diabetic peripheral neuropathy [4]. The polyol pathway theory suggests that hyperglycaemia leads to excess intra-neuronal glucose levels. To counter this effect an alternative catabolic pathway is performed to convert glucose to sorbitol, which is then ultimately converted to fructose. These oxidative reactions bring about certain levels of stress which metabolically damage the neurons and hence, hinder proper nerve function [5]. Another theory suggests that the activation of protein kinase C β-2 due to intracellular hyperglycaemia is at fault. Heightened levels of this particular protein will cause an increase in basement membrane matrix protein deposits, activation of leucocytes and, smooth muscle proliferation and contraction. All these physiological effects combined reduce endoneural circulation, damaging the nerve [6]. The final theory behind the physiologic progression of neuropathy involves advance glycation end-products (AGEs). Their formation is credited to a complex transitional process that takes place when proteins are exposed to hyperglycaemic environments. These type of environments convert the proteins into AGEs by non-enzymatic glycosylation. Accumulation of these end-products results in inadvertent deposition in vulnerable tissues, such as nerves. If these AGE's are allowed to inhabit nerve tissues, thickening of endoneural vessel walls occurs thus inhibiting the microcirculation of the nerve [7].

Distal symmetrical polyneuropathy is the most common type of neuropathy affecting 11–50% of patients living with diabetes. The progression of neuropathy is gradual and subtle, occurring over many years with increasing age and duration of diabetes. Neuropathy usually affects the small, unmyelinated C fibres responsible for pain and temperature sensation [4]. Early signs of neuropathy include paraesthesia and autonomic nervous system dysfunction. This makes detection of neuropathy in its early stages quite demanding since temperature and pain sensation are not easily assessed. Large myelinated axons are also effected. These are responsible for conduction of proprioception, light touch, vibratory and pain stimuli. Tingling, burning, numbness, allodynia or deep lancinating pain are common symptoms of large-fibre involvement [8].

Early diagnosis of neuropathy is extremely important for the prevention of limb-treating conditions and morbidity. Furthermore, the progression of neuropathy may reach an irreversible stage making early diagnosis and treatment essential for patients living with diabetes mellitus [9]. However to date, although various testing modalities are available for the diagnosis of neuropathy, there is no current agreement/consensus on a definite ideal screening test which should be used in clinical practice to detect neuropathy [10]. In fact, besides nerve conduction studies there is no clinical screening diagnostic tool available which has been scientifically proven to obtain a reliable confirmation of diabetic peripheral neuropathy [1].

There are a number of different clinical screening tests/modalities available for neuropathy and each test focuses on one of the four aspects of sensation, which are vibration, pressure, temperature and pain [11]. This study aimed to compare three commonly used noninvasive screening modalities/tests used in the detection of DPN in a primary care setting. Vibration testing is extremely important since in the initial stages of neuropathy, the vibratory sensory system is amongst the first component of the nervous system to be affected [12].

Vibration testing involves assessment of the posterior nervous column which is responsible for both proprioception and vibration [13]. The ankle and distal aspect of the hallux are the two locations where vibration testing is usually conducted. The neurothesiometer, 128 Hz tuning fork and the VibraTip where chosen for this study. Although all three modalities are frequently used in the primary care setting for the detection of DPN, to date studies and diabetes foot screening guidelines report conflicting results and do not confirm which of these three different screening tools/modalities can detect neuropathy in the diabetic foot. Furthermore, inconsistencies are reported in the literature with regards to sensitivity and specificity of these screening tools. The sensitivity and specificity of the 128 Hz tuning fork has been calculated to be at about 53% and 99% respectively [3]. Large epidemiological prospective studies have reported that the neurothesiometer has a sensitivity of 83%, a specificity of 63%, and a positive likelihood ratio of 2.2 and a negative likelihood ratio of 0.27 for predicting ulcer formation in neuropathic feet over years [14]. The VibraTip has been reported to be more reliable than the tuning fork in bedside evaluation of peripheral neuropathy however the tuning fork was found to have a higher specificity than the VibraTip, although values were not statistically significant [15].

This gap in knowledge and the need for identifying the most appropriate method to accurately detect DPN has prompted the need to conduct this study. This research sought to determine which of these mentioned tools is the most effective at detecting diabetic neuropathy by testing of vibration perception.

2. Method

A prospective non-experimental comparative multi-centre cross sectional study was conducted in various Primary Health Centres. One hundred participants living with Type 2 diabetes for at least 10 years were recruited using a convenience sampling method in the study if they satisfied the inclusion and exclusion criteria. This study was approved by the University Research Ethics Committee and all participants provided informed consent before any data collection. All investiga-

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