

Comparison of Vibration Threshold of Upper Limb During Upper Limb Neurodynamic Test 1 in Individuals with and without Type II Diabetes Mellitus

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Abstract

Background: Patients with Type II diabetes mellitus are showed to affect the sensory, reflex and motor systems in distal extremities. Studies have examined the mechanosensitivity and vibration threshold (VT) in type II diabetes mellitus patients in the lower limb and compared it with normal individuals. There is scanty literature available in comparison of the VT in the upper limb in type II diabetes mellitus patients with non-diabetic individuals.

Methods: Thirty type II diabetic individuals (age – 55.60 ± 9.79 years) and 30 asymptomatic individuals (age – 53.43 ± 9.96) without diabetes mellitus participated in the study. Tester at the baseline for both the groups using a biothesiometer measured VT. Biothesiometer is capable of deriving a vibration of 100 Hz. Following VT evaluation at the baseline, the tester performed the ULNT1 for all the subjects. During the sequence of the ULNT1, VT was measured at initial onset of pain (termed as P1) and short of maximum pain (P2) as experienced by the patient.

Results: There was a statistical significant difference in VT between diabetic and non-diabetic group subjects. VT was raised in the diabetic group at all the three level of evaluation (baseline, P1 and P2) compared to the non-diabetic group with a p value < 0.001.

Conclusion: VT of the upper limb is higher in individuals with type II diabetes mellitus as compared to non-diabetic individuals.

Keywords: Vibration threshold, ULNT1, Diabetes mellitus

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1. INTRODUCTION:

Diabetes mellitus is a group of metabolic syndrome which is characterized by increased levels of glucose in the blood resulting from impaired insulin secretion, insulin action, or both [1]. Type II diabetes mellitus is most common form which is a disease of insulin resistance that usually has relative (rather than absolute) insulin deficiency [1]. Earliest functional change in diabetic nerve is change in axonal excitability due to alterations in ion conductance of axon membrane due to metabolic processes directly affecting the nerves, microvascular abnormalities of the endoneurium and autoimmune inflammation [2]. Four main mechanisms have been postulated to underlie the pathogenesis of nerve pathology in diabetes mellitus, which are metabolic processes directly affecting nerve fibres, endoneurial microvascular disease, autoimmune inflammation and deranged neurotrophic support [2,3]. These changes are due to these effects of elevated levels of glucose which involves the peripheral nerve in type II diabetes mellitus subjects. It has been documented that most of type II diabetic patients have peripheral neuropathy [4]. Among the nerves, there is a tendency of the large diameter nerve fibers that mediate sense of vibration to get involved first in diabetes mellitus [5].

Neurodynamic tests involve sequential limb movements that are employed to elicit the connection between physiological and mechanical types of different mechanisms [6, 7]. The main ambition of using these different tests in assessment of a nerve function is to mechanically stimulate and mobilize neural tissues in order to get an expression of their mobility and sensitivity to mechanical stresses so as to arouse the physiological responses [7, 8]. In order to assess the upper limb nerve function, the standard upper limb neurodynamic test 1 (ULNT1) is usually used as it evokes symptoms of distribution of the median nerve because the forces generated by this test are biased towards this structure [8]. There are various techniques of assessing the conductivity of nerve such as nerve conduction velocity that basically assesses the motor and sensory aspects of the nerve. Whereas, vibration threshold (VT) reflects particular function of the peripheral nervous system especially the somatosensory pathway [8,9].

Type II diabetes mellitus patients are showed to affect the different multimodal systems (sensory, reflex and motor) in distal extremities [10, 11]. Mechanosensitivity in diabetes mellitus patients should be considered as an essential inclusion in the assessment to predict the extent of involvement of the nerve [11]. Studies have also been done to determine the VT in lower limb in normal individuals but there is scanty literature available in comparison of the VT in the upper limb in type II diabetes mellitus patients when compared with non diabetic subjects.

2. METHODS

2.1 Study Design

Pre-test post-test 2-group cross sectional study design was conducted in department of Physical therapy, King Khalid University, Abha, Saudi Arabia.

2.2 Subject Selection

Thirty subjects with type II diabetes with age of 55.60 (SD± 9.79) were recruited from the outpatient university physiotherapy clinic who were referred from registered practitioner. All subjects were evaluated by experienced physical therapist in the field of diabetes and musculoskeletal examination, and the subjects who met inclusion criteria were enrolled into the study. Diabetic subjects with clinical signs of neuropathy were excluded from the study. Recruitment of age matched normal subjects was done through advertisement in the King Khalid University for voluntary participation in the study. The subjects were included if are aged between 30 to 70 years, have had no H/diabetes, upper limb disorders, Cervico-brachial pain syndrome, acute inflammatory/ demyelinating diseases, any recent surgeries in upper limb. 30 control subjects were recruited by age to ensure a similar match to the diabetic group. The mean age of the subjects was 53.43±9.96. All the subjects were familiarized with the study equipment and testing procedure in the first session prior to the actual testing session. All the subjects read, understood and signed an informed consent prior to the commencement of the study and University ethical committee approved the study.

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3. MEASUREMENT OF VIBRATION THRESHOLD (VT)

VT was measured by the same tester at the baseline for both the groups using a bioesthesiometer capable of delivering a vibration of 100 Hz. The subjects were made to sit comfortably on a chair with hand and arm placed completely on the pillow. The probe of the Vibrometer was placed at the pulp of the distal phalanx of the thumb [12]. Either right or left hand was tested. The subjects were shielded from the Vibrometer display during testing to avoid any bias. At baseline, tester 1 first increased the vibration to a point where the subject perceived the stimulus. This was taken as appearance of vibration. Then the intensity was further increased and slowly reduced until they identified the disappearance of the stimulus. This measurement was done thrice and the average of the six values was taken as the vibration threshold.

After the VT was taken at the baseline, the tester performed the ULNT1 (adopted from M. Shacklock [8] for each individual. For this, a pressure

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biofeedback inflated to 50 mm Hg was used to prevent shoulder elevation. Then the shoulder was abducted to 90-110 degrees followed by complete external rotation, forearm supination, wrist and finger extension. The last component of ULNT1 was elbow extension and elbow extension value was recorded using universal goniometer as a measure of mechanosensitivity. During the sequence of the ULNT1, the occurrence of the first response of elbow extension i.e. pain considered as P1 was noted. The angle of its occurrence was measured with the universal Goniometer and VT at this position in the same manner as that of baseline was taken for both the groups by the tester 2. The next occurrence of the symptom i.e. P2 at which any further movement was intolerable was noted. The corresponding elbow extension angle of P2 was measured. The range of elbow extension was reduced until the feeling of discomfort disappeared and VT was measured at this point for both the groups by the tester 2. The reduction of elbow extension was adopted to avoid the masking of pain for perception of vibration. The measurement of VT was measured for both diabetic individuals and age matched normal individuals.

4. DATA ANALYSIS AND RESULTS:

SPSS 20.0 version for windows software was used to analyse the data. To be considered statistically significant the p value was set at ≤ 0.005 . Demographic data regarding the age (yrs.), sex and duration of individuals with type II diabetes mellitus and non-diabetic individuals are summarized in table no. 1

Table no. 2 and Figure 1 shows the comparison of the VT between the diabetic and the non-diabetic group at three levels i.e. VT at baseline, VT at P1 and VT at short of P2. There was a statistical significant difference between the VT of diabetic and non-diabetic group at the three levels with a p value < 0.001 . This states that the VT was found to be raised in the diabetic group at all the three levels compared to the non-diabetic group. Thus, VT of the upper limb is higher in individuals with type II diabetes mellitus as compared to non-diabetic individuals.

Table 1: Study population characteristics [n = 60] (Mean \pm SD).

	Diabetic group n= 30	Control group n= 30
Age (yrs)	55.60 \pm 9.79	53.43 \pm 9.96
Sex Male: female	19:11	15:15
Duration of diabetes (yrs.) median (IQR)	5.50 (1.75 – 10.50)	–

Table 2: Comparison of Vibration threshold between and within groups.

Outcome measure	Diabetic group Mean±SD	Control group Mean ±SD	p value
VT baseline	6.06 ± 1.98	3.72 ± 1.08	Between groups: p < 0.001
VT at P1	6.24 ± 2.16	4.04 ± 1.24	
VT at less than P2	6.46 ± 2.13	3.99 ± 1.40	
p value	Within groups 0.755		

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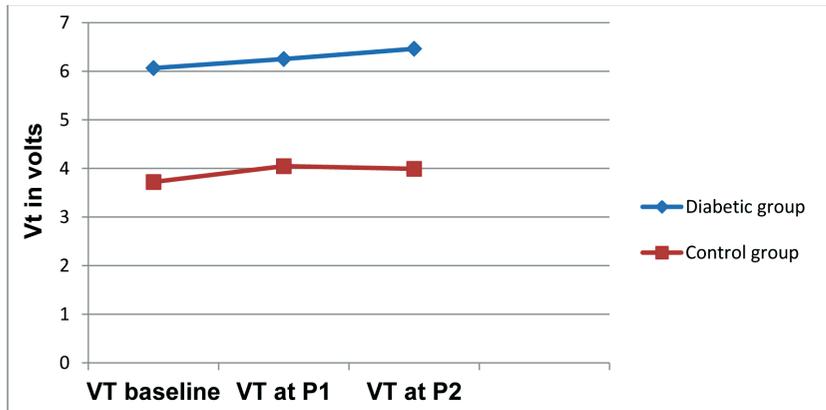


Figure 1: Trend line showing Vibration Threshold difference between groups and within group.

DISCUSSION

Our study aimed at comparing the VT of the upper limb during ULNT1 in individuals with type II diabetes mellitus and non-diabetic individuals. As per the results, the VT was found to be increased in the individuals with type II diabetes mellitus as compared to the non-diabetic individuals.

VT is a measure of conductivity i.e. a function of the axon in conducting the impulse from the external receptor [13]. Thus, alteration of the VT in type II diabetic individuals may be due various reasons. Recent studies show endoneurial hypoxia and reduced neural perfusion are reduced in human

and animal models with diabetes. Investigations on subjects with diabetic neuropathy showed structural changes in nerve microvasculature such as basement membrane thickening, endothelial cell hyperplasia and pericyte degeneration etc.¹⁴⁻¹⁶. Reduced endoneural perfusion is also contributed by arterio-venous shunting. These changes strongly correlate between nerve pathology and vascular changes. Vasa nervorum changes that occur early are caused by diabetes mellitus insult, because of such the balance between vasodilator and vasoconstrictor are altered [14]. All the above said findings might have contributed for increase in VT findings in diabetic group subjects when compared to non-diabetic subjects.

The findings of our study regarding the VT are in contrast with the study done by David A Gebler et al [17]. They conducted a study to check the vibratory and thermal thresholds in normal and diabetic individuals using a Thermal Sensitivity Tester and Optacon Tactile Tester (OTT). They did not find the vibratory and thermal threshold of diabetic subjects to be different from the asymptomatic / normal individuals. Our study findings cannot be compared with these study findings, as the methodological considerations are different from our study. A Gebler et al [17] study showed that the thermal and vibratory thresholds were found to be increased in diabetic individuals with neuropathy [17] but our study did not include subjects with neuropathy. Further studies are required to see if there will be differences in VT in subjects with diabetic neuropathy and non-neuropathic subjects.

The limitations of our study include that the study sample was not calculated and the sample of 30 is less to compare between diabetics and non-diabetics.

CONCLUSION

We conclude that VT in subjects with type 2 diabetes mellitus is increased when compared to asymptomatic individuals. Physical therapists should consider this finding during evaluation and management of patients with type II diabetes mellitus.

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