Sensory Changes In The Upper Limb In Type 2 Diabetic Patients - A Case Control Study

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THE USE OF A TWO POINT DISCRIMINATION TEST IN THE DIAGNOSIS OF UPPER LIMB NEUROPATHY IN TYPE 2 DIABETES

Context: Sensory changes are associated with diabetic neuropathy and the assessment of sensation is commonly done in the foot to prevent ulcers. Though sensory changes may be present in the upper limb also, its documentation is not done routinely. **Aims:** To find out the two point discrimination values and other sensory changes in the upper limb in type 2 diabetic patients. **Settings and design:** This was a cross sectional design using a case control study, which was done in a hospital with both inpatients and outpatients.Methods and material: 75 subjects with type 2 diabetes were included in the case group; patients with a diagnosed case of neuropathy were excluded. These were compared with age and sex matched subjects in the control group with no diabetes. Vibration sensation, pressure threshold and two point discrimination were assessed on the hands in both the groups. The Duruoz's Hand Index was used to assess the general functional status with regards to the abilities of daily living in both the groups. **Statistical analysis:** The data was analysed by using the SPSS package, version 13, with p values <.05 being taken as significant. **Results:** In the diabetic group, approximately 11 % of the patients had the loss of protective sensation; the median value of the vibration sensation was 11-14 volts as compared to 3-4 volts in the control group and the mean value of the two point discrimination was 4-5mm. The results were significantly different between the diabetic and the control groups. The median value of DHI was eight in the diabetic group. **Conclusions:** All the sensations which were checked were altered in the diabetic patients, thus indicating the possible underlying neuropathy changes. The two point discrimination test can be used to detect upper limb neuropathy in patients with type 2 diabetes, which can further be validated with nerve conduction velocity tests. A sensory evaluation should be done in the upper limb, especially with patients who had diabetes for more than five years, for the possible presence of neuropathy.

Key Words: Two point discrimination, Hand, Type 2 diabetes

Key Messages:

- In some instances, patients with diabetic neuropathy have few complaints, but their physical examinations reveals mild to moderate severe sensory loss.
- The sensibility testing is important in diabetic patients with sensory neuropathy, to prevent any complications that may arise because of the loss of sensation. Various modalities of touch sensation like pressure, vibration and two-point discrimination (TPD) are used to test sensation loss or sensibility.
- Sensory changes may be present in the upper limb, possibly due to the underlying neuropathy. The patients may be unaware of this and may be at a risk of causing harm to their hands through burns or injuries.
- All the sensations were found to be decreased in the diabetic group as compared to the non diabetic group. Though no symptoms were reported by these patients, the clinical evaluation of the sensations revealed the changes.
- Sensations should be checked on the hands of all the patients who have had diabetes for more than five years. Changes in the sensations also indicate the possible presence of neuropathy in the upper limb, which can further be confirmed by Nerve Conduction studies.

INTRODUCTION

Diabetes mellitus is associated with reduced life expectancy, significant morbidity and a diminished quality of life [1], affecting more than 135 million people worldwide and the number is expected to reach approximately 300 million by 2025. [2] Type 2 diabetes accounts for 90-95% of the total diabetes cases [3] and is age related, peaking at 60-69 years of age [4]. Because of its gradual progression, usually a mean of 4-7 years will pass by from the initial onset of type 2 diabetes until the time of its diagnosis [3]. Diabetic neuropathy is among the most common long term complications of diabetes, affecting up to 50%-60% of the patients who have poor glycaemic control [5]. It is one of the most important factors for foot ulceration in diabetes mellitus (DM) patients. [6] In some instances, patients with diabetic neuropathy have few complaints, but their physical examinations reveals mild to moderate severe sensory loss. [7] These symptoms are commonly seen in the feet before they are seen in the hands and arms (upper extremity). [8]

In sensory nerve damage, as the sensory loss ascends and reaches approximately mid calf, it appears in the hands. This gradual evocation causes the typical 'stocking glove' sensory loss which reflects preferential damage according to axon length,

the longest axons being affected first. [9] Sensibility testing is thus important in diabetic patients with sensory neuropathy to prevent any complications that may arise because of the loss of sensation. Various modalities of touch sensation like pressure, vibration and two-point discrimination (TPD) are used to test sensation loss or sensibility.[10]

The main purpose of the examination of vibration is to assess the evidence of dysfunction in the peripheral sensory nerves in the extremities, mainly during neuropathy, as the vibration sense diminishes with a variety of neuropathies [11] and it may be the first sensation to be lost. Its loss can be detected before the loss of the Two point Discrimination. [9] Vibration loss in the upper extremity suggests severe neuropathy. The more severe the vibratory loss, the more likely the finding is to be clinically significant. [9]

Static Two Point Discrimination has been used as a tool to measure sensory loss and to determine digital nerve integrity in diabetes mellitus patients. [10],[6] Although the method is subjective, the patient must report whether or not the pressure is felt, it is more reliable than the previously available methods and it is a quantitative measure of the sensory loss. [6]

The Semmes-Weinstein monofilament testing divided the huge population of diabetes mellitus patients into subjects who were at risk and it is one of the primary screening methods for measuring cutaneous sensibility . [10]

The onset of the loss of sensation in the lower extremities is the commonest symptom which is associated with peripheral neuropathy [12] and all these methods have been shown to be of value in identifying the patients who are at a risk of diabetes related foot complications. [13] Sensory changes may be present in the upper limb, possibly due to the underlying neuropathy. The patients may be unaware of this and may be at a risk of causing harm to their hands through burns or injuries. The aim of this study was to assess and document the sensory changes in the upper limb of the diabetic patients and to compare them with those which were seen in normal individuals.

MATERIALS AND METHODS

This study was approved by the Time Bound Ethical Committee and the Scientific Committee. Informed consent was taken from all the subjects.

Seventy five subjects with type 2 diabetes between the age group of >40 to 82 years and in whom the duration of diabetes was more than five years, were taken for the study by using a non random sampling method. The exclusion criteria were, patients with a diagnosed case of upper limb diabetic neuropathy, neuropathy other than diabetic neuropathy or radiculopathy , patients with autonomic neuropathy and those with diagnosed neuro musculoskeletal disorders of the hand, symptomatic peripheral vascular disease, traumatic nerve injury of the upper limb, trauma to the hand, congenital anomalies of wrist and hand, skin infections and Hansen's disease.

The control group consisted of 75 subjects who were matched according to their age and sex and those who were not diagnosed with diabetes.

The Pressure Threshold was tested by using the Touch-Test TM 5 piece Hand Kit (NC12772). The subject's extremity was rested on a stable, padded surface. The testing was done in a quiet area to help the subject to fully pay attention to the testing procedure. The subject's vision was occluded. The testing procedure proceeded from the small to large Semmes-Weinstein Monofilaments. It was tested on the palmar surface of the index finger, the little finger and the first dorsum web space. The filament was pressed at a 900 angle against the skin until it was bowed, was held in place for 1.5 seconds and was then removed. A stimulus was applied in the same location up to three times to detect a response. A single response indicated a positive response. For 4.56 and 6.65, the stimulus was applied only once.

The vibration was measured by using Vibrotherm - Dx (serial No – V20611113). The subject's hands were held in a relaxed, supported position on the table. The procedure was explained to the patients and they were told that they would experience the vibration sensation. Vibration testing was done on the pulps of the index finger and on the little fingers of both the hands. The readings were recorded in Volts.

An Aesthesiometer device (Baseline ® Evaluation Instruments 7-Piece Hand Evaluation Set) which was marked in millimeters was used for checking the two point discrimination. The subject's hands were fully supported on the examining table, while the vision was occluded. The finger tips of the index finger and the little fingers of both the right and left hands were tested, as they are very important in the active and tactile scanning of an object. The testing was done with a five mm distance between the two points. One or two points were applied lightly to the finger tip in a random sequence in a longitudinal orientation to avoid a crossover from the overlapping digital nerves. The applications were stopped just at a point of blanching. Seven out of ten responses were accurate for scoring. The testing was stopped at 15 mm if the responses were inaccurate at that level.

The Duruöz's Hand Index (DHI) is a functional disability scale, a self-report questionnaire that is efficient in the accurate assessment of hand dysfunction in diabetic patients. [14] The DHI was used to assess the general functional status with regards to the abilities of daily living in both the groups.

All statistical tests were carried out by using the Statistical Package for Social Sciences, version 13.0 for Windows software. The differences were considered as statistically significant at p values <0.05.

The Mann Whitney test was used to find out the differences in the vibration and the two point discrimination between the diabetic and the non diabetic groups. The Students unpaired t test was used to find the difference between the pressure threshold values in both the diabetic and the non diabetic groups. The correlation between the three variables and with the duration of diabetes was done by using Pearson's Correlation Coefficient at a 95% confidence interval.

RESULTS

The mean duration o diabetes in the subjects was 9.4±5.9 years. When the sensations were correlated to the duration of diabetes, all the sensations showed a partial positive co-relation with the duration of diabetes. Pressure threshold right index (r=0.35, p=.002), vibration right index (r=0.29, p=0.013), two point discriminatio right index (r=0.38, p=0.001).

1. Pressure Threshold Variations

The variation in the monofilament which was perceived by the subjects in the diabetic and non diabetic groups is shown in [Table/Fig 1].

Group	Monofilament	Frequency	Percent
Diabetic	2.83	0	0
	3.61	24	32.0
	4.31	43	57.3
	4.56	8	10.7
	Total	75	100.0
Non Diabetic	2.83	34	45.3
	3.61	41	54.7
	4.31	0	0
	4.56	0	0
	Total	75	100.0

[Table/Fig 1]: Pressure threshold variation in diabetic and non diabetic group

COMPARISON

When compared between the groups, the difference in the pressure threshold values was significant for all the three sites [Table/Fig 2].

Part tested	Group	Minimum pressure threshold	Maximum Pressure threshold	Median	T value	P value
Index finger	Diabetic	3.61	4.56	4.31	14.04	< 0.0001*
	Non Diabetic	2.83	3.61	3.61		
Little finger	Diabetic	3.61	4.56	4.31	14.04	< 0.0001*
	Non Diabetic	2.83	3.61	3.61		
Web space	Diabetic	3.61	4.56	4.31	14.04	< 0.0001*
	Non Diabetic	2.83	3.61	3.61		

[Table / Fig 2]: Amount of alcohol consumed in ml per day

*- Significant (p< .05)

2. Vibration Sensation and Two point discrimination

The diabetic group had a significantly higher value (p<0.0001) as compared to the non diabetic group [Table/Fig 3] and [Table/Fig 4].

Part tested	Group	Minimum Vibration perceived (volts)	Maximum Vibration perceived (volts)	Median	Mann Whitney tes Z value	P value
Index right	Diabetic	4	35	11	8.3	p<0.0001*
	Non Diabetic	4	9	5		
Index left	Diabetic	3	33	11	8.5	p<0.0001*
	Non Diabetic	2	9	6		
Little right	Diabetic	3	50	13	8.6	p<0.0001*
	Non Diabetic	2	10	6		
Little left	Diabetic	3	45	14	8.9	p<0.0001*
	Non Diabetic	2	9	6		

[Table/Fig 3]: Comparison between Vibration perception threshold values in diabetic and non diabetic group

*- Significant (p< .05)

3. Correlation between the three sensations which were evaluated.

A significant correlation was found between two point discrimination and vibration perception on the right side index finger (r =.37, p= .001) and on the right side little finger (r = .48, p= .000), between pressure threshold and the vibration perception threshold on the right side Index finger(r =..47, p= .000) and on the right side little finger (r = .49, p=.000). A high correlation was also found between the pressure threshold and two point discrimination on the right side Index finger (r =.36, p= .002) and on the right side little finger (r = .36, p= .002).

Part tested	Group	Minimum Distance perceived (volts)	Maximum Distance perceived (volts)	Median	Mann Whitney test Z value	P value
Index right	Diabetic	3	15	4	9.4	p<0.0001*
	Non Diabetic	2	4	2		
Index left	Diabetic	3	15	5	9.4	p<0.0001*
	Non Diabetic	2	5	2		
Little right	Diabetic	3	15	5	9.4	p<0.0001*
	Non Diabetic	2	8	3		
Little left	Diabetic	3	15	5	9.4	p<0.0001*
	Non Diabetic	2	5	3		

[Table/Fig 4]: Comparison between two point discrimination values in diabetic and non diabetic group

*- Significant (p< .05)

The Dorouz's Hand Index median value was 8.00 in the diabetic group.

DISCUSSION

The evaluation of sensibility in the hand of the diabetic patients is of para- mount importance in order to provide the proper identification of the group with neuropathy. Sensory changes in the hand could help to detect the involvement of UL neuropathy in the diabetes group.

In most of the previous studies, various modalities of sensations like temperature, vibration, point localization and 2 PD have been used to measure sensory loss in the diabetic foot [10,15,16] Neuropathy is more severe in the lower limbs than in the upper limbs, as the lower limb nerves are affected more often than the upper limb nerves [17]; for this reason, probably less studies have assessed UL neuropathy.

In our study, we assessed the sensations and compared the values with age and sex matched non diabetic populations. Patients with the involvement of type 2 diabetes for > 5 years, between the ages of 40 years and 82 years, were taken. Previous studies have mentioned that neuropathy should be suspected in all patients for more than five years. [18],[19] In our study, all the sensations showed a high correlation with the duration of diabetes. Kasturi BA et al study showed that a significant relationship exists between the duration of the disease and the grade of neuropathy. Also, the study observed that the severity of the neuropathy increases as its duration increases. [17] Dutta et al's study also showed that the prevalence of peripheral neuropathy had a highly significant correlation with the duration of diabetes. [20]

Monofilaments have been shown to be one of the gold-standard instrumentations [21] which can be used for measuring cutaneous sensibility [10], and to check large fibre neuropathy. [5] Our study found that in the non diabetic group, 45.3% subjects were able to perceive 2.83, which showed that normal sensation was present in this group. 54.7% participants were able to perceive a diminished light touch (3.61). These findings could be because of skin thickness

and a normal ageing manifestation. [21] This indicates that these participants had fairly used their hands and that they had good temperature appreciation and good protective sensation. [22] But in the diabetic group, 2.83 was not perceived by anyone. Only 32.0% perceived the diminished light touch, 57.3% perceived a diminished protective sensation and 10.7% perceived the loss of protective sensation. According to Callahan AD, the diminished protective sensation indicates the diminished use of the hand, difficulty in manipulating some objects and the tendency to drop objects, and the weakness of the hand. But appreciation of pain and temperature is present that helps to keep a subject away from the injury. The loss of protective sensation indicates little use of the hand, and a diminished or the absence of temperature appreciation, which may cause injury easily. [22] In our study, since 10.7% subjects fell in this category, these subjects needed to be given advice regarding protecting themselves from injury.

When compared between the two groups, the diabetic group was found to have a significantly higher value as compared to the non diabetic group. The reason for the decreased sensation in the diabetic group could be due to the involvement of large myelinated A-beta fibres which were responsible for the pressure threshold. These nerve fibres get involved in neuropathy, thus indicating that neuropathy may be present in the diabetic group. [10]

The ability to feel vibrations is reflected by the function in the large nerve fibres and in the delicate receptors which are located in the finger pulps. [23] The investigation of the Vibrotectile sense in the finger pulps is important to detect any large fibre neuropathy in the hands of diabetics, since such subjects may have neurological symptoms that sometimes may be over looked in clinical practice.

Vibration perception sensitively reflects the disturbances in the function of the fast adapting mechanoreceptors and in the thick myelinated sensory nerve fibres. Both are commonly affected in diabetes [10]. We found that there was a highly significant difference between the vibration sensations in both the diabetic and the non diabetic patients. As the vibration is conducted by the large myelinated nerve fibres in the diabetic patients, the longest nerves are affected first, possibly due to a metabolic abnormality, leading to the failure of axonal transport and subsequent degeneration [24], causing more impaired sensations among the diabetic patients. [25]

The two point discrimination (2PD) is the current recommended method for evaluating the loss of sensation or the degree of sensation loss in the diabetic patients. [6] Our study also found that the two point discrimination values were very highly significant between the diabetic and the non diabetic individuals. R. Periyasamy et al in their study, also found that the 2PD values of the DM subjects were always higher than that of the normal subjects. [10]

Our study also found that there was a significant correlation between vibration, perception threshold and two point discrimination in the diabetic group. Vibration sensation is used to detect the changes in neuropathy. Since there was a significant correlation between vibration and two point discrimination, for assessment purposes in clinical settings, the two point discrimination test can be used to detect changes in the upper limb due to neuropathy, as it is a relatively easy test and as elaborate instrumentation is also not required. Whereas in the non diabetic group, there was no significant difference between the vibration perception threshold and the two point discrimination. This indicates that in the non diabetic group, all the tests should to be checked in the clinical settings.

Our study showed that the mean value of DHI was 12.3±14.01 among the diabetic group. As the DHI score ranges between 0-90, the mean value of DHI in our study showed that patients with diabetes had less hand-related activity limitation. In the non diabetic group, activity limitations were not present.

The results of the present study have shown a significant difference in the sensations which were found in the diabetic and the non diabetic groups. All the sensations were found to be decreased in the diabetic groups as compared to those in the non diabetic groups. Though no symptoms were reported by these patients, the clinical evaluation of the sensations revealed the changes. This may suggest the presence of underlying neuropathy, which can be further confirmed by nerve conduction studies. Electrophysiology has been used as the gold standard to detect and verify large fibre neuropathy in the upper extremity. [23] Peripheral neuropathy can be diagnosed if abnormal Nerve Conduction Velocity is present. [20] Nerve Conduction studies (NCSs) are strongly correlated with the underlying structural changes and are the least subjective and the most reliable single criterion standard. [26] Our patients who presented with decreased sensations could be subjected to Nerve Conduction (NC) tests to find any association between the clinical testing methods and the NC test which is considered to be the gold standard. Once neuropathy is established, significant recovery does not occur. Hence, the early detection of neuropathy helps in aggressive treatment. [17]

This study also signifies that sensory changes are present in the hands of diabetics and that a considerable amount of patients fall into the category that needs advice regarding the care of their hands. Sensations should be checked in the hands of patients with diabetes for at least five years.

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