EVALUATION OF CLINICAL NEUROPATHY IN DIABETES: USE AND LIMITATIONS OF BIOTHESIOMETER

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SUMMARY

The usefulness of biothesiometry (BM) in evaluation of peripheral neuropathy was assessed in this study in 149 non-insulin dependent diabetic patients. The results were analysed separately in those with > 50 years and < 50 years of age as the BM readings were known to vary with age in normal individuals also.

Duration of diabetes showed significant correlation with BM readings on great toe; but not at the ankle. There was no correlation found with the plasma glucose and HbAl values and also with subjective neurological symptoms. There was correlation with objective clinical findings of peripheral neuropathy. After control of hyperglycaemia, BM readings improved significantly at the ankle; but not at the great toe.

Quantification of the vibratory sensory threshold is possible by biothesiometry and is a sensitive index. BM readings can change in a short period with acute reduction in blood glucose; similar to those seen in nerve conduction velocities. However, further studies are required to determine the correlation of changes in BM readings with those in nerve conduction studies.

Introduction

Symmetrical peripheral sensory neuropathy is one of the most common complications of diabetes. Often it is also a presenting symptom. Both subjective and objective signs could be detected in patients with diabetes mellitus at diagnosis and often the subjective symptoms do not correlate with the findings on clinical examination.

The introduction of the biothesiometer (BM) has made it possible to quan-

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tify the decrease in vibratory sensory threshold (VST) in diabetics, which is an early sign of sensory neuropathy (1, 2). Recent studies have described the usefulness of this technique in detecting early sensory deficit (3). One report cautioned against the limitations of biothesiometer (4). This study was taken up to evaluate the usefulness of biothesiometry compared to clinical findings and to evaluate the effect of control of hyperglycaemia on changes in biothesiometry.

Material and Methods

The study group consisted of 149 non-insulin dependent diabetic (NIDDM) patients. The diagnosis of diabetes and classification as NIDDM was based on the WHO study group report on diabetes mellitus (5).

A detailed analysis of symptoms and clinical evaluation for peripheral neuropathy was performed in all diabetic subjects. To obviate observed bias, three different observers did the recording of the symptoms, the clinical examination and the biothesiometric studies respectively. Patients were questioned specifically regarding four common symptoms of diabetic neuropathy namely pain, burning sensation, numbness and pins and needles in the feet. The presence of one or more symptoms was taken as evidence of subjective neuropathy. The clinical evaluation included recording of sensory deficits (pain, temperature, touch and joint sensation) and testing of deep tendon reflexes. The presence of sensory deficit and/or absence of ankle jerks was considered positive for objective diabetic neuropathy. The third observer measured the vibration sensory threshold (VST) using the biothesiometer (Biomedical Instrument Co., Ohio).

Procedure

Biothesiometry was performed in all patients in the supine position. The procedure was explained to the patients before the test. The plastic tip of the BM was placed lightly against the plantar pulp of the distal phalanx of the great toes. The examiner turned the knob clockwise causing the needle to be deflected from zero upwards and the vibration of the electrode was thus gradually increased. Once the point at which the subject could perceive the vibration was reached, the turning of the knob was stopped after taking it a few units beyond the point of perception. The knob was then turned in the opposite direction until the subject could no longer perceive the vibration. The procedure was repeated 2-3 times until the value agreed within one unit. The readings were taken twice on both great toes and two values averaged. Similarly the readings were taken twice on each malleoli and the four values averaged. Since it is known that BM readings vary with the age even in normal individuals (6) the analysis was done separately in patients with < 50 years and > 50 years of age. Fifty non diabetic subjects were studied as controls ($35 < 50$ years and $15 > 50$ years).

The BM readings were repeated in 50 patients who achieved glycaemic regulation (Post Prandial Plasma Glucose $<$ 180 mg%, average of three estimations) within a week. All of them were below 50 years of age.

Statistical Analysis

All values are given as Mean $\pm$ SD. Statistical analysis was done using Mann-Whitney-U test.

Results

The clinical details of the study subjects are given in Table-1. Table-2 shows the correlation of BM readings with clinical parameters. The patients were divided into groups according to age viz. Group I (< 50 years) and Group II (> 50 years). Duration of diabetes showed significant correlation with BM readings on great toe, but did not correlate with readings at the ankle. The BM readings did not correlate with the blood glucose concen-

TABLE — 1

Clinical Characteristics of the Study Groups.

	Total	M	F	Mean Duration in years	Mean Age of onset in years	PP Plasma Glucose mg% ±S.D.	HbAl %
Controls	50	35	15	—	—	110±16	6.8±1.0
Initial Group	149	92	57	11.9	40.8	278±86	10.7±2.2
Follow-up Group	50	41	19	11.7	43.3	151±20	10.2±1.8

TABLE — 2

Mean BM readings in volts (mean±SD) and various clinical parameters.

Groups & Parameters	Great Toe Age<50 yrs.	Age<50 yrs.	Ankle Age<50 yrs.	Age<50 yrs.
Controls	7±1.5	10±1.5	8±3	11±2.1
Duration				
< 5 years	15±10.4	14.8±7.6	18.1±9.2	18.6±7.8
> 5 years	18.7±10.6	18.4±9.4	18.6±8.5	19.1±7.2
	P<0.05	P<0.05	N.S.	N.S.
HbAl				
< 8 per cent	16.9±9.4	18.2±13.3	18.9±9.0	19.0±8.2
> 8 per cent	17.6±14.1	18.7±12.6	18.2±8.7	17.9±8.6
	N.S.	N.S.	N.S.	N.S.
Subjective symptoms of Neuropathy				
Absent	17.9±8.8	18.8±12.2	19.8±9.2	18.8±9.7
Present	18.8±12.6	19±10.6	20.1±10	19.6±8.6
	N.S.	N.S.	N.S.	N.S.
Objective evidence of Neuropathy				
Absent	15.2±10.4	15.4±10.2	17.3±9.8	17.6±9.0
Present	19.6±11.2	18.8±9.4	18.5±10.2	19.0±8.1
	P<0.05	P<0.05	P<0.05	P<0.05

TABLE — 3

Effect of glucoregulation on biothesiometer readings.

	Great Toe	Ankle	PPBG mg% ±SD
Normal Controls	7±1.5	8±3	110±16
Patients			
Before Control	18.8±8.5	20.2±8.8	278±86
After Control	16.5±4.2	17.7±6.5	151±20
	N.S.	P<0.05	

trations or with the HbA1 at the time of the study. There was no correlation of the BM readings and the subjective neurological symptoms, but there was correlation with the objective clinical findings of peripheral neuropathy. The mean BM readings in great toe and ankle in controls and the two groups are shown in Table-2.

After control of hyperglycaemia, biothesiometer readings improved significantly at the ankle but not at the great toe. The changes in the BM readings on follow-up are shown in Table-3.

Discussion

In patients with overt symptoms of diabetic neuropathy, quite often the subjective symptoms do not correlate with objective findings on examination. Biothesiometry is a useful technique, as it provides a number that quantifies the vibratory sensory deficit. The results of this study show that the biothesiometer readings correlate fairly well with the objective findings on clinical examination. The quantification of the vibratory sensory loss describes one aspect of the neurological deficit as well as provides a sensitive index for study of patients followed over a period of time. It is well known that subclinical neuropathy can be detected by electromyography involving motor conduction velocity and sensory potential (7). A large section of patients with hyperglycaemia could exhibit slowing of motor conduction velocity without any clinical manifestation and this is rapidly reversible with control of hyperglycaemia (7). The clinical significance of this early abnormalities detected on EMG studies is not clear. However the slowly acquired sensory changes and loss of tendon reflexes are more reliable, and provides definite markers on clinical examination. A recent study by Boulton et al (3) showed that impaired vibratory perception determined by biothesiometer was strongly associated with diabetic foot ulceration. In a study of Najemmik et al (4) sensory potential did not correlate well with the biothesiometer readings.

There are a number of papers which report on improvement in nerve conduction after control of hyperglycaemia (7-9). To our knowledge this is the first report where changes in biothesiometry after control of diabetes have been reported. In this study there was significant improvement in BM readings in the ankle within a week after control of diabetes. This implies that BM readings can change acutely in days with change in blood glucose concentration. This is similar to the improvement seen with nerve conduction studies (7).

Further studies are needed to determine whether there is any correlation bet-

ween the change in BM readings and the improvement seen in nerve conduction studies, especially sensory potentials.

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