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Type-2 Diabetes Mellitus with Neuropathy: "Clinical Presentation and Nerve Conduction Study Findings"

Mondal NT[1*], Khan MM[2], Hasan MQ[3], Hossain MI[4]

[1]Nelson Taposh Mondal, Associate Professor (Medicine), Enam Medical College & Hospital, Saver, Dhaka, Bangladesh
[2]Mohammed Momenuzzaman Khan, Associate Professor and Head of Department (Department of Neurology), Enam Medical College & Hospital, Saver, Dhaka, Bangladesh.
[3]Mohammad Quamrul Hasan, Associate professor (Gastroenterology), Enam Medical College and Hospital, Saver, Dhaka, Bangladesh.
[4]Mohammad Ibrahim Hossain, Assistant Professor, Department of Physical Medicine and Rehabilitation, Enam Medical College & Hospital, Savar, Dhaka, Bangladesh

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***Corresponding author:** Nelson Taposh Mondal

Abstract **Original Research Article**

Background: Diabetes mellitus (DM) is one of the chronic diseases all over the world. The prevalence of diabetes is rapidly rising all over the globe at an alarming rate. Diabetes mellitus (DM) is a metabolic disorder characterized by chronic hyperglycemia with disturbance of carbohydrate, fat, and protein metabolism resulting from defects in insulin secretion, insulin action or both with an increased risk of neuropathy and other complications. ***Objective:*** To describe the clinical features and findings of nerve conduction study among the patients presented with diabetic neuropathy. ***Methods and Material:*** The study was conducted at the outpatient department of Uttara Crescent Hospital, Uttara, Dhaka, Bangladesh. Total 83 patients presented with a history of diabetes for 20 years and above and having features of neuropathy are included in this study. Patients who are suspected having neuropathy due to any other known cause were excluded from this study. Detail history regarding complaints of neuropathy was taken. History of symptoms like paraesthesia, tingling sensation, burning feet, hyperaesthesia, foot ulcer, history of weakness and gait abnormality was noted. Complete nervous system examination was performed and nerve conduction study was done. ***Results:*** Among the total 83 presented with neuropathy; the mean (±SD) age (Years) was 51.80 ((±10.24) with a range of 35-60 years (Fig-1). Out of total 83 patients, 60.24% (n=50) were male and 39.76% (32) were female. In our study we found that out of 83 patients 74 patients (89%) presented with tingling sensation at limbs, 52 patients (62.65%) had burning feet, 47 patients (56.63%) had diminished or loss of vibration sense, and 34 patients (41%) patients have diminished light touch. Above finding suggested that most patients presented with sensory symptoms. Out of 83 patients 42 patients (50.60%) had diminished ankle jerk and only 6 patients presented with foot ulcers. In this study out of 83 patients all patients (100%) had neuropathy involved in their lower limb and 35 patients (42%) had additional involvement in their upper limb. In this study nerve conduction study was performed in tibial, sural, medial plantar and lateral plantar nerves in lower limb and median and ulnar nerve in upper limb. We found that involvement of tibial and sural nerve was more common, that is 86% and 82% respectively. Involvement of medial and lateral plantar nerve was similar and that is 76%. In our study 70 patients (84%) found to have distal symmetrical polyneuropathy and 6 patients (7.23%) had isolated motor neuropathy and there are also various other combinations found. **Conclusion:** Distal symmetrical polyneuropathy is most common form of diabetic neuropathy. Involvement of tibial and sural nerve is more common in diabetic neuropathy.

Keywords: Diabetes, Nerve Conduction, Diabetic Neuropathy.

INTRODUCTION

Diabetes mallitus is not a single disorder but a range of autoimmune, metabolic and genetic disorder associated with hyperglycaemia. It has many causes, but most commonly type 1 or type 2 diabetes are two broad categories. Type 1 diabetes is generally

considered as a result from autoimmune destruction of insulin-producing β cells in the pancreas, leading to marked insulin deficiency, whereas type 2 diabetes is characterized by reduced sensitivity (resistant) to the action of insulin and an inability to produce sufficient insulin to overcome this 'insulin resistance'. Hyperglycaemia causes both acute and long-term problems. Acutely, high glucose and lack of insulin can result in marked symptoms, metabolic decompensation and hospitalisation. Chronic hyperglycaemia is responsible for diabetes specific 'microvascular' complications affecting the eyes (retinopathy), kidneys (nephropathy) and feet (neuropathy).

Diagnostic criteria of diabetes and pre-diabetes (WHO criteria)

Diabetes is confirmed by

- Either plasma glucose in random sample or 2 hrs after a 75 g glucose load ≥11.1 mmol/L (200 mg/dL) or
- Fasting plasma glucose ≥7.0 mmol/L (126 mg/dL) or
- HbA1c ≥48 mmol/mol

In asymptomatic patients, two diagnostic tests are required to confirm diabetes; the second test should be the same as the first test to avoid confusion

Pre-diabetes' is classified as

- Impaired fasting glucose: Fasting plasma glucose ≥6.1 mmol/L (110 mg/dL) and <7.0 mmol/L (126 mg/dL)
- Impaired glucose tolerance: Fasting plasma glucose <7.0 mmol/L (126 mg/dL) but 2-hr glucose after 75 g oral glucose drink is 7.8–11.1 mmol/L (140–200 mg/dL)

The diagnostic criteria for diabetes have been selected to identify a degree of hyperglycaemia that, if untreated, carries a significant risk of microvascular disease, and in particular diabetic retinopathy. Less severe hyperglycaemia (prediabetic level) is not associated with a substantial risk of microvascular disease, but is connected with an increased risk of large vessel disease (e.g., atheroma leading to myocardial infarction) and with a greater risk of developing diabetes in future.

The prevalence of diabetes is rapidly rising all over the globe at an alarming rate [1]. It is estimated that 45% of patients with DM develop diabetic polyneuropathy [2]. Diabetes can be treated and its consequences can be avoided or delayed with diet, increased physical activity, medication, regular screening and treatment for complication [3]. Diabetic neuropathy causes substantial morbidity and increases mortality and is the main initiating factor for foot ulceration, Charcot arthropathy, and lower-extremity amputation [4]. Neuropathy occurs secondary to metabolic disturbance, and is related to the duration of diabetes and the degree of metabolic control. Pathological features occur in any peripheral nerves, they include axonal degeneration of both myelinated and unmyelinated fibers, with thickening of the Schwann cell basal lamina, patchy segmental demyelination and abnormal intraneural capillaries (with basement membrane thickening and microthrombi).

Classification of diabetic neuropathy

1. Somatic: Polyneuropathy; symmetrical, mainly sensory & distal, asymmetrical, mainly motor & proximal (including amyotrophy) and Mononeuropathy (including mononeuritis multiplex)
2. Visceral (autonomic): Cardiovascular, Gastrointestinal, Genitourinary, Sudomotor, Vasomotor and Pupillary

Various classifications of diabetic neuropathy have been proposed. But motor, sensory and autonomic nerves may be involved in varying combinations, so that clinically mixed syndromes usually occur. Diabetic neuropathy is defined as "the presence of symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after exclusion of other causes".[5] Neuropathy may be asymptomatic; but the most common clinical signs are diminished perception of vibration sensation distally, 'glove and stocking' impairment of all other modalities of sensation and loss of tendon reflexes in the lower limbs. In symptomatic patients, sensory abnormalities are predominant. Symptoms include paraesthesiae & numbness in the feet (and, rarely, in the hands), pain & burning sensations in the limbs, cutaneous hyperaesthesia and, when severe, an abnormal gait (commonly wide-based. Motor neuropathy sometimes called diabetic amyotrophy, this presents as severe and progressive weakness and wasting of the proximal muscles of the lower limbs and it is commonly accompanied by severe pain. There may also be mononeuropathy and autonomic neuropathy. Weakness and atrophy in the small muscles of foot may cause deformity. The routine evaluation of DPN is based on patient symptoms and physical examination; however, simple screening methods are of limited value for the elderly, in early neuropathy and in the presence of neurological co-morbidities [6]. Early diagnosis and management are crucial; to failure to diagnose diabetic polyneuropathy can lead to serious consequences, including disability and amputation [7]. Patients with type 2 diabetes mellitus may present with distal polyneuropathy after only a few years of known poor glycaemic control; sometimes, these patients already have neuropathy at the time of diagnosis.

Nerve conduction studies (NCS) and electromyography (EMG) can document the characteristics of the neuropathy (e.g., axonal or demyelinating) and the localization (e.g. mononeuropathy versus radiculopathy or distal

neuropathy) and, possibly, the severity and even prognosis for morbidity. Multiple consensus panels recommend the inclusion of electrophysiological testing in the evaluation of diabetic neuropathy. These same panels recommend the use of NCV/EMG procedures in clinical research studies. Nerve conduction studies are commonly used to confirm diabetic polyneuropathy [8], and should be included as part of the definition of distal polyneuropathy for clinical research [9]. They provide objective data and are generally more accurate than clinical evaluation [10]. Nerve conduction studies are composed of several tests, including motor and sensory responses. Each test is performed in few individual nerves and provides two to five different parameters.

MATERIAL AND METHODS

The study was conducted at the outpatient department of Uttara Crescent Hospital, Uttara, Dhaka, Bangladesh. Total 83 patients presented with a history of diabetes for 20 years and above and having features of neuropathy are included in this study. Patients who are suspected having neuropathy due to any other known cause were excluded from this study. Detail history regarding complaints of neuropathy was taken. History of symptoms like paraesthesia, tingling sensation, burning feet, hyperaesthesia, foot ulcer, history of weakness and gait abnormality was noted. Complete nervous system examination was performed to look for signs such as diminished ankle jerk, & diminished power and sensory examination for loss of light touch, superficial pain, temperature sense, vibration and joint position was done. Written and informed consent from patient was taken before their inclusion in this study and before nerve conduction study.

Nerve conduction studies were performed using *Clarity Octopus NCV/EMG machine*. Patient's limb was placed in relaxed position as any movement of limb can hamper the results. It is important to keep the limb warm as any degree rise or fall in temperature can change the results so room temperature was maintained between 21 to 23°C. It is important to reduce electrode impedance which is usually achieved by applying electrode gel under the electrode and by affixing the electrode with adhesive tape to the skin.

RESULTS

Socio-demographic features

A) Age and sex of the patients:

Total 83 neuropathy patients included our study. Shows (Fig-1) that the mean (±SD) age (Years) of the patients is 51.80 ((±10.24) with the range of 35-60 years. Out of total 83 patients, 60.24% (n=50) are male and 39.76% (32) are female.

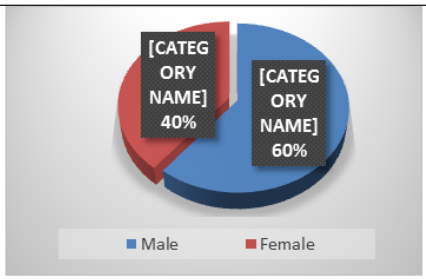

Fig-1: Distribution of patients by sex.

B) Distribution of patients based on socio-demographic features are given in the table below

Table-1: Distribution of patients based on Occupation, Educational Qualification and Average monthly family income.

	Number of patients	Percentage
Occupation		
House-wife	20	24.10%
Farmer	16	19.28%
Businessman	12	14.46%
Service holder	10	12.05%
Teacher	4	4.82%
Day labour	9	10.84%
Others	12	14.46%
	83	100.00%
Educational Qualification		
Illiterate	6	7.23%
Non-formal education	6	7.23%

Primary level	9	10.84%
Secondary level	10	12.05%
Higher secondary level	16	19.28%
Graduate	30	36.14%
Post-graduate	6	7.23%
	83	100.00%
Average Monthly Family Income		
10000 taka and below	4	4.82%
10001 to 20000 taka	22	26.51%
20001 to 40000 taka	37	44.58%
40001 taka and above	20	24.10%
	83	100.00%

C) ***Patients' presentation***

In our study we found that out of 83 patients 74 patients (89%) presented with tingling sensation at limbs, 52 patients (62.65%) had burning feet, 47 patients (56.63%) had diminished or loss of vibration sense, and 34 patients (41%) patients have diminished light touch. Above finding suggested that to us most patients presented with sensory symptoms. Out of 83 patients 42 patients (50.60%) had diminished ankle jerk and only 6 patients presented with foot ulcers.

Table-2: Patients' Presentations.

Symptoms	Frequency	Percent
Tingling Sensation of limb	74	89.16%
Burning Feet	52	62.65%
Loss or impaired vibration sense	47	56.63%
Impaired Light Touch	34	40.96%
Loss or Diminished Ankle Jerk.	42	50.60%
Foot ulcers	6	7.23%

D) Diabetic neuropathy and Nerve conduction study

In this study out of 83 patients all patients (100%) had neuropathy involved in their lower limb and 35 patients (42%) had additional involvement in their upper limb. In this study nerve conduction study was performed in tibial, sural, medial plantar and lateral plantar nerves in lower limb and median and ulnar nerve in upper limb. We found that involvement of tibial and sural nerve was more common, that is 86% and 82% respectively. Involvement of medial and lateral plantar nerve was similar and that is 76%.

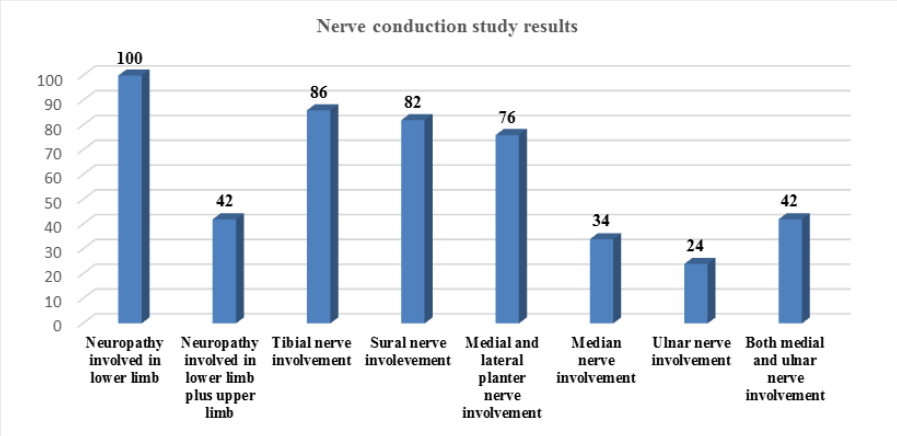

Fig-2: Nerve conduction study results.

In our study 70 patients (84%) found to have distal symmetrical polyneuropathy and 6 patients (7.23%) had isolated motor neuropathy and there are also various other combinations found.

DISCUSSION

Most recognized neurologic complications associated with diabetes is involvement of the peripheral nervous system. The diabetic neuropathies include several distinctive clinical syndromes with differing clinical manifestations, anatomic distributions, clinical courses, and possibly underlying pathophysiologies. [11-14] In our study out of 83 patients of diabetic neuropathy 42 patients i.e. 50.6%

have diminished ankle jerk, 47 patients i.e. 56.63% have diminished or loss of vibration sense, 34 patients i.e. 41% patients have diminished light touch. Observation from another study reveals similar pattern; that 29 patients i.e. 58.0% have diminished or loss of vibration sense, in 21 patients i.e. 42.0% patients have diminished light touch and 20 patients i.e. 40% patients have loss of joint position senses [15-17]. In our study 100% patients had involvement of lower limb and only 42% patients had additional involvement in their upper limb; this is nearly similar to another study where 47% patients had involvement of upper limb [18, 19]. Involvement of medial and lateral plantar nerve was similar i.e. 76%; involvement of median and ulnar nerve was 50% and 46% respectively. Isolated median and ulnar nerve involvement was not found in our study. Same types of finding were observed few other studies [20, 21, 22].

Nerve conduction studies performed with surface or needle electrode, surface technique are more widely used, easier to perform, more comfortable and produce results that are easier to measure [23].

Result of nerve conduction studies show amplitude, distal latency of compound muscle action and sensory potentials, conduction velocity of fastest conducting fiber, and minimal F- wave latencies. Nerve conduction studies do not always correlate well with symptoms and signs [24]. In our study we found symptoms and signs of neuropathy which are consistent with findings of nerve conduction studies. In our study we found that nerve conduction detects neuropathy changes even before signs develop. Severity of neuropathy is also well established by nerve conduction findings. Sensory neuropathies (SNAP) are always better appreciated by nerve conduction studies than conventional vibration sensation tests. Motor neuropathies (CMAP) which is not picked on routine clinical examination are observed in nerve conduction studies. The nerve conduction studies are of better diagnostic value than vibration perception threshold, diabetic neuropathy symptom score, and diabetic neuropathy examination score.

CONCLUSION

In our study of diabetic neuropathy, we observed that signs and symptoms of diabetic neuropathy are consistent with the findings of nerve conduction studies performed on tibial, sural, medial plantar, lateral plantar, median and ulnar nerves. Involvement of tibial and sural, distal symmetrical polyneuropathy is most common form of diabetic neuropathy as compared with other forms of sensory/motor neuropathy.

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