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ORIGINAL RESEARCH

Study of clinical patterns of diabetic neuropathy in patients of type 2 diabetes mellitus in a tertiary care hospital

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Introduction: Diabetic neuropathy manifests with sensory, motor, and autonomic functions. The symptoms of neuropathy are highly unpleasant, affecting the quality of life. The diagnosis of diabetic neuropathy is often delayed, so there remains a substantial need for its early diagnosis for timely management.
Objective: The aim of this study was to describe patterns of diabetic neuropathy, study nerve conduction study (NCS) findings in diabetic patients with symptoms of neuropathy, and find the relationship between clinical patterns of neuropathy and worsening glycemic control.
Methods: This is a hospital-based cross-sectional study of 104 known cases of diabetes mellitus patients with symptoms of neuropathy visiting Sree Gokulam Medical College and undergoing NCS as a part of the investigation. The Fisher's exact test was used accordingly.
Results: The mean age of the study population was 63.1 $\pm$ 6.1 years. The mean body mass index was 27.1 $\pm$ 3.2 kg/m^2. Overall, 97.1% patients had HbA1c above 7%. Approximately 54.8% of patients presented with tingling sensation, 42.3% with burning sensation, 31.7% complained of pain, 16.3% presented with numbness, 51% patients had abnormal NCS findings in sural and peroneal nerves, 54.8% in superficial peroneal nerve, 46.2% in tibial nerve, and 31.7% patients had abnormal NCS findings in median nerve. Based on the patterns of neuropathy, 68.2% had sensory motor polyneuropathy, 5.8% had carpal tunnel syndrome, 20.2% had small fiber neuropathy (normal NCS), 2.9% had tibial mononeuropathy, and 2.9% had ulnar mononeuropathy. No association was found between the clinical patterns of neuropathy and glycemic control (HbA1c).
Conclusion: The most common pattern of neuropathy was sensory motor polyneuropathy. The common nerves involved were sural, peroneal, and superficial peroneal nerve, and the most common presenting complaint was tingling sensation, followed by burning sensation. There was no relationship between clinical patterns of neuropathy and worsening glycemic control.

Keywords: diabetes mellitus, nerve conduction study, diabetic neuropathy

Introduction

Diabetes cause damage to and malfunction of various organs. Type 2 diabetes mellitus (DM) is more prevalent in the older population, creating a major health burden. Diabetic neuropathy is defined as the presence of symptoms and signs of peripheral nerve dysfunction in diabetes patients after excluding other causes. Neuropathies decrease the quality of life (1). Diabetic neuropathy manifests with various symptoms, including a burning sensation, pain down the leg, tingling, etc. These symptoms are highly unpleasant, while secondary complications are even more severe and can lead to fractures, amputations, and death (2). Nerve conduction study (NCS) has high sensitivity and specificity for the detection of diabetic peripheral neuropathy, and relating the symptoms of neuropathy with NCS findings is essential for early detection and management so as to prevent its outcomes. There are several clinical and electrophysiological

distribution patterns like sensory motor polyneuropathy (distal, proximal, symmetrical, and asymmetrical), multiple mononeuropathies, and mononeuropathy (focal), and it remains unclear which pattern is most common (3). Hence, this study aimed to find the clinical pattern of diabetic neuropathy and study the NCS findings in patients with type 2 DM who had symptoms of neuropathy.

Materials and methods

This is a hospital-based cross-sectional study conducted in the department of Neurology and General Medicine at Sree Gokulam Medical College and Research Foundation. The patients were known cases of DM with symptoms of neuropathy who came to Sree Gokulam Medical College and underwent NCS as a part of their investigation and management. The study was done for a period of 12 months, that is, from May 2021 to April 2022. Patients who were between the age groups of 30 and 70 years, who had a known case of type 2 DM and were coming to the hospital with symptoms of neuropathy, and who were willing and capable of providing informed consent were included. Diabetic neuropathy is defined as the presence of symptoms/signs of nerve dysfunction in patients with DM after the exclusion of other causes leading to neuropathy. Hence, the following categories of patients were excluded: chronic alcoholics, patients with cerebrovascular accidents and peripheral neuropathy due to other causes, patients with peripheral arterial disease or with evidence of limb ischemia, and patients who refused to give informed consent. A total of 104 patients who matched the inclusion and exclusion criteria were selected by using consecutive sampling method. After getting approval from the institutional ethics committee and obtaining informed written consent from each patient coming to the department of Neurology and General Medicine of Sree Gokulam Medical College, the details about the study were explained to all the patients included. Detailed history for symptoms of neuropathy experienced by the patients like pain, tingling sensation, burning, numbness, gait abnormality, duration of diabetes, history of comorbidities other than diabetes like hypertension and dyslipidemia, and prior history of alcohol and smoking were assessed. A central nervous system examination was done to know the extent of neuropathy, which included testing for sensations like light touch, superficial and deep pain, temperature sensation, perception of vibration, joint position, and ankle reflex. Body mass index (BMI) was measured for all patients after taking the weight and height of each patient. Blood samples were collected from all the patients, and the blood parameters like FBS, PPBS, HbA1c, and serum creatinine were investigated. Only patients with known cases of type 2 DM and symptoms of diabetic neuropathy were included in the study. NCS was performed on the tibial, sural, femoral, median and lateral plantar, peroneal, and superficial peroneal nerves of bilateral lower limbs and radial, ulnar, and median nerves of bilateral upper limbs. The collected data were entered into a computer and analyzed by the SPSS statistical software package. The necessary statistical tables were constructed. The Fisher's exact test was used accordingly.

Results

A hospital-based cross-sectional study was conducted in patients with type 2 DM who had symptoms of neuropathy and were admitted to the ward and attended OPD in the Department of General Medicine and Neuromedicine in Sree Gokulam Medical College and Research Foundation. A total of 104 patients who satisfied our inclusion and exclusion criteria were included in the study. The results of the study are as follows.

Gender and age-wise distribution of study population

The distribution of gender showed that males were the majority with 68.3% (71 patients), and females were less, at approximately 31.7% (33 patients) (**Figure 1**).

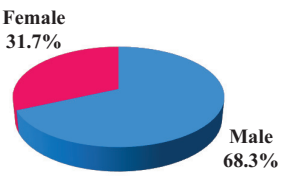

FIGURE 1 | Distribution of study population based on gender.

The mean age of the study population is 63.1 ± 6.1 years, among them those with less than 50 years were 2.9% (3 patients), those in between 51 and 60 were 25% (26 patients), and those between 61 and 70 were 72.1% (75 patients) (**Figure 2**).

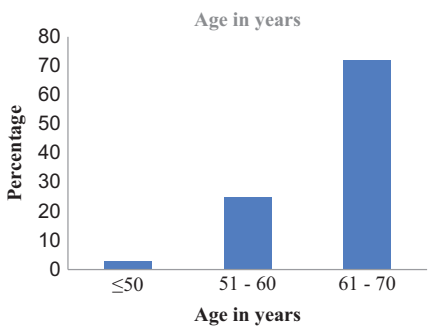

FIGURE 2 | Distribution of study population based on age.

The age and gender-wise distribution showed that males were more affected than females, and most of them were in the age group between 61 and 70 years.

Hypertension and dyslipidemia profile of study population

When the comorbidities other than diabetes that is hypertension and dyslipidemia were considered, our study showed that about 43% (45 patients) of them had dyslipidemia and 46.2% (48 patients) had hypertension (Figure 3).

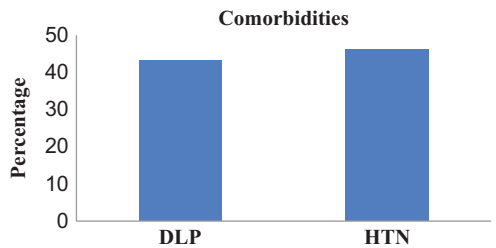

FIGURE 3 | Percentage distribution of comorbidities among study population.

Body mass index

Mean BMI of the study population (Table 1) was 27.1 ± 3.2 kg/m2.

TABLE 1 | Frequency distribution of study population based on BMI.

BMI	Frequency
Normal	28
Over weight	49
Obese	27
Total	104

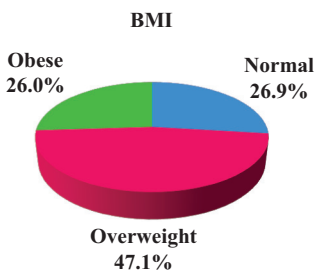

FIGURE 4 | Percentage distribution of study population according to BMI.

Blood investigations

The mean blood investigation showed abnormal levels of FBS, PPBS, and HbA1c (Table 2).

Fasting blood sugar profile

TABLE 2 | Frequency distribution of study population according fasting blood sugar profile.

FBS	Frequency
>150 mg/dl	85
<150 mg/dl	19
Total	104

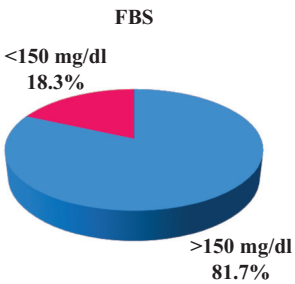

FIGURE 5 | Percentage distribution of study population according to fasting blood sugar profile.

Postprandial blood sugar profile (Table 3)

TABLE 3 | Frequency distribution of study population according to postprandial blood sugar profile.

PPBS	Frequency
>200 mg/dl	81
<200 mg/dl	23
Total	104

Hba1c Profile (Table 4)

TABLE 4 | Frequency distribution of study population according to HbA1c profile.

HbA1C	Frequency
>7%	101
<7%	3
Total	104

Approximately 37 patients had creatinine value more than 1.3 mg per deciliter, while 67 patients had values less than 1.3 mg per deciliter (Figure 6).

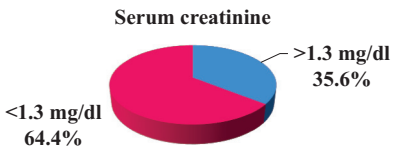

FIGURE 6 | Serum creatinine.

Upper limb and lower limb involvement (Tables 5, 6)

TABLE 5 | Frequency distribution of study population according to upper limb involvement.

Upper limb involvement	Frequency
Present	36
Absent	68
Total	104

TABLE 6 | Frequency distribution of study population according to lower limb involvement.

Lower limb involvement	Frequency
Present	95
Absent	9
Total	104

Symptoms present (Table 7)

TABLE 7 | Frequency distribution of study population according to the symptoms present.

Symptoms present	Number of patients
Tingling sensation	57
Burning sensation	44
Pain	33
Numbness	17
Abnormal gait	16
Diminished deep pain perception	2
Diminished superficial pain sensation	53
Diminished appreciation of light touch	56
Diminished temperature perception	47
Diminished vibration sense	51
Diminished joint position sense	22
Impaired ankle reflex	45

Nerve conduction study findings (Table 8)

TABLE 8 | Frequency distribution of number of patients according to abnormal NCS findings in the nerves.

NCS	No of patients with abnormal NCS
Ulnar nerve	18
Median nerve	33
Radial nerve	5
Tibial nerve	48
Sural nerve	53
Femoral nerve	14
Median plantar nerve	31
Lateral plantar nerve	25
Peroneal nerve	53
Superficial peroneal nerve	57

Pattern of neuropathies

TABLE 9 | Frequency distribution of study population according to pattern of neuropathy diagnosed.

Pattern of neuropathy diagnosed	Frequency
Sensory motor neuropathy	71
Carpal tunnel syndrome	6
Small fiber neuropathy	21
Tibial mononeuropathy	3
Ulnar mononeuropathy	3
Total	104

Among the total of 104 patients studied, 68.2% had sensory motor polyneuropathy as the diagnosis, 5.8% had carpal tunnel syndrome involving the median nerve, 20.2% had small fiber neuropathy, that is, their NCS findings were normal but had symptoms of neuropathy involving the small fibers, 2.9% had isolated tibial neuropathy, and other 2.9% patients had ulnar mononeuropathy involving upper limbs (Table 9).

The data depicted in (Table 10) show that there is no association between the pattern of diabetic neuropathy and the worsening glycemic control (HbA1c).

Discussion

A hospital-based cross-sectional study was done on patients with type 2 DM who had symptoms of neuropathy and were admitted to the ward and attended OPD. In our study, various clinical patterns of diabetic neuropathy in patients with symptoms of neuropathy were studied; they included sensory motor neuropathy, small fiber neuropathy, carpal tunnel syndrome, and mononeuropathies like tibial mononeuropathy and ulnar mononeuropathy. Among these, the most common pattern was the sensory motor neuropathy. The most common presenting complaint of the patients was tingling, followed by burning sensation, and other symptoms included pain and numbness. Other parameters of neuropathy like the absence of superficial and deep pain, perception of light touch, temperature, vibration, joint position, ankle reflex, and abnormal gait were also studied. The most common nerves involved in our study were the sural nerve, peroneal nerve, and superficial peroneal nerve in the lower limbs and the median nerve in the upper limbs. There was no relationship between the clinical pattern of neuropathy and worsening glycemic control. A study done by Manish Patil and Avon Kumardhruw at the Pt. Jawaharlal Nehru Memorial Medical College, Chhattisgarh, also showed that tingling sensation and burning feet are the most common presenting complaints of the diabetic patients with neuropathy. In their study, the most common nerves involved were the sural nerve and the tibial nerve. Similarly,

TABLE 10 | Association between clinical patterns of neuropathy and glycemic control (HbA1c).

	HbA1c				Total		χ^2	df	Fisher's exact test p
	>7%		<7%						
	N	%	N	%	N	%			
Sensory motor neuropathy	70	98.6	1	1.4	71	100			
Carpal tunnel	5	83.3	1	16.7	6	100			
Small fiber neuropathy	20	95.2	1	4.8	21	100	5.063	4	0.236
Tibial mononeuropathy	3	100	0	0	3	100			
Ulnar mononeuropathy	3	100	0	0	3	100			
Total	101	97.1	3	2.9	104	100			

another study done by AL Kakrani and Gokhale at Dr DY Patil Medical College, Pune, also showed that tingling and burning were the most common presenting complaints of the diabetic neuropathy patients; it also showed that all patients had lower limb involvement and less than half of the patients had upper limb involvement, which is similar to our study, where lower limb involvement was more common than upper limb involvement. Similarly, this study also showed that distal symmetrical polyneuropathy is the most common form of diabetic neuropathy, and the same was the result in our study, where sensory motor polyneuropathy was the most common pattern of neuropathy in DM (4). A multicenter study conducted in the United Kingdom by MJ Young, AJM Boulton et al. found that the prevalence of diabetic peripheral neuropathy increases with age from 5% in 20–29 years to 44.2% in 70–79 years (5). In our study, most of the patients were between the age group of 61 and 70 years, that is, 72.1%, and those below 60 years were 25%. A study by Melaine L Aaberg, Draion M Burch, et al. demonstrated that males developed neuropathic complications 4 years earlier than females. In our study, male patients (68.3%) were more than female patients (31.7%). In a study by Tae Jung Oh et al., where approximately 65 patients were enrolled, 44.6% were diagnosed with DPN, and all these patients had a higher BMI and waist circumference than the subjects without DPN, concluding that abdominal obesity was associated with DPN. Similarly, in our study, about 47.1% were overweight and 27% were obese, and these patients had severe neuropathy compared to the patients with normal BMI. A study by Dr Amit Kumar et al. conducted at Surabhi Medical College, Meerut, on the correlation between the severity of diabetic peripheral polyneuropathy and glycosylated hemoglobin levels found that the more severe the deficits, the higher the HbA1c. In our study, 97.1% of patients had HbA1c values above 7, and only 2.9% had values below 7. In diabetic patients, nerve entrapment is more common than nerve infarction, and among entrapment neuropathies, carpal tunnel syndrome is three times more common in diabetic patients than in the normal population (6). In our study, approximately 5.8% of patients had carpal tunnel syndrome, and 2.9% each had isolated tibial and ulnar mononeuropathy. Apart from the above findings, this study also shows that there is no correlation between worsening glycemic control and various clinical patterns of diabetic neuropathy.

Conclusion

The most common pattern of neuropathy was sensory motor polyneuropathy. Lower limb was the first to be affected by diabetic neuropathy, followed by upper limb. The most common nerves involved were the dural nerve, peroneal nerve, and superficial peroneal nerve in lower limb and the median nerve in the upper limb. The most common presenting complaint was tingling, followed by burning sensation. Most of the patients had diminished superficial pain and touch sensation, followed by diminished temperature perception. There was no relationship between clinical patterns of neuropathy and worsening glycemic control.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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