SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Bhoi *et al*., 2025
doi: 10.21276/SSR-IIJLS.2025.11.3.43

Original Article

open access

Clinical and Electrophysiological Evaluation of Diabetic Neuropathy and its Correlation with Retinopathy and Microalbuminuria in Type 2 Diabetes Mellitus

Kamala Kant Bhoi[1]*, Deepak Jaiswal[2], Naresh Verma[3]

[1]Neurologist, Department of Medicine, Shri Balaji Institute of Medical Science, Mowa, Raipur, India
[2]Associate Professor, Department of Medicine, Shri Balaji Institute of Medical Science, Mowa, Raipur, India
[3]PG Student, Department of Medicine, Shri Balaji Institute of Medical Science, Mowa, Raipur, India

***Address for Correspondence:** Dr. Kamala Kant Bhoi, Neurologist, Department of Medicine, Shri Balaji Institute of Medical Science, Mowa, Raipur, Chhattisgarh-492001, India
E-mail: drkkbhoi@yahoo.co.in

Received: 05 Jan 2025/ Revised: 13 Feb 2025/ Accepted: 24 Apr 2025

ABSTRACT

Background: Diabetic peripheral neuropathy (DPN) is a disabling microvascular complication in type 2 diabetes mellitus (T2DM). Its association with retinopathy and microalbuminuria suggests a shared pathophysiological mechanism. To assess the clinical and electrophysiological features of DPN and its correlation with retinopathy and urinary microalbumin levels in T2DM patients.

Methods: A hospital-based cross-sectional observational study was conducted on 95 T2DM patients over 18 months. Neuropathy was assessed clinically using DNS and MNSI scores and electrophysiologically through nerve conduction studies (NCS). Retinal findings were obtained via fundus examination, and nephropathy was evaluated by spot urine albumin-creatinine ratio.

Results: Out of 95 patients, the majority showed signs of sensorimotor neuropathy. Significant correlations were observed between poor glycemic control (HbA1c >8%), longer diabetes duration, microalbuminuria, and retinopathy with neuropathy severity. Electrophysiological findings confirmed that the sural and tibial nerves were most affected.

Conclusion: Nerve conduction studies are a sensitive tool for the early detection of DPN. Their correlation with microalbuminuria and retinopathy supports the integrated screening of microvascular complications in T2DM.

Key-words: Diabetic Peripheral Neuropathy, Nerve Conduction Study, Retinopathy, Microalbuminuria, Type 2 Diabetes Mellitus

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from insulin resistance and/or impaired insulin secretion [1]. It predisposes individuals to various microvascular and macrovascular complications, significantly impacting morbidity and quality of life [2]. Among these, DPN is one of the most common and early occurring microvascular complications in T2DM, affecting approximately 50% of patients [3].

How to cite this article
Bhoi KK, Jaiswal D, Verma N. Clinical and Electrophysiological Evaluation of Diabetic Neuropathy and its Correlation with Retinopathy and Microalbuminuria in Type 2 Diabetes Mellitus. SSR Inst Int J Life Sci., 2025; 11(3): 7608-7613.

Access this article online
https://iijls.com/

DPN results in a wide spectrum of symptoms, such as pain, tingling, numbness, and loss of protective sensation, often leading to foot ulcers, infections, and amputations if left undiagnosed [4]. NCS is considered the gold standard for the objective diagnosis of DPN, aiding in the early detection of nerve damage even before clinical signs appear [5].

In addition to neuropathy, other microvascular complications, such as diabetic retinopathy and nephropathy, are commonly seen in long-standing T2DM [6]. Urinary microalbumin excretion (UAE) serves as an early marker of nephropathy, indicating glomerular dysfunction that may progress to end-stage renal disease (ESRD) if untreated [7]. The fundoscopic examination helps detect early changes of diabetic retinopathy, which often coexists with other microvascular complications [8]. Recent evidence indicates a close interrelationship between DPN, retinopathy, and nephropathy, suggesting

doi: 10.21276/SSR-IIJLS.2025.11.3.43

a shared pathophysiological basis involving chronic hyperglycemia-induced microangiopathy [9]. This triad, if recognized early, may guide comprehensive screening and intervention strategies.

The current study aims to assess the clinical and electrophysiological patterns of peripheral neuropathy in T2DM patients and to evaluate its correlation with urinary microalbumin levels and fundus changes in a tertiary care hospital setting.

MATERIALS AND METHODS

Study Design, Period, and Setting- This hospital-based cross-sectional observational study was conducted in the Department of General Medicine (OPD and IPD), Shri Balaji Institute of Medical Science, Raipur, Chhattisgarh, India. The study period extended over 18 months, from August 2023 to February 2025.

Study Population- The study included patients aged over 18 years with a known diagnosis of type 2 diabetes mellitus and symptoms suggestive of peripheral neuropathy as per RSSDI 2022 guidelines.

Sample Size- A total of 95 patients with type 2 diabetes mellitus were included in the study. The sample size was estimated based on the prevalence of diabetic neuropathy (45.6%) from a prior study, considering a 10% margin of error.

Sampling Technique- Consecutive sampling was employed for subject recruitment.

Inclusion Criteria

- Diagnosed cases of type 2 diabetes mellitus with symptoms suggestive of peripheral neuropathy
- Patients aged ≥18 years
- Patients willing to provide written informed consent

Exclusion Criteria

- Peripheral neuropathy due to causes other than diabetes (e.g., trauma, myopathy, inherited disorders)
- History of type 1 diabetes mellitus
- Patients on drugs causing neuropathy or those affecting glycemic control (e.g., steroids)
- Presence of thyroid dysfunction, chronic renal failure, hepatitis, malignancy, or rheumatologic diseases

Study Procedure- A detailed clinical history was recorded, including age, sex, duration of diabetes, treatment history, and neuropathy-related symptoms like tingling, burning sensation, foot ulcers, or gait disturbances. Physical examination included central nervous system evaluation, Romberg's test, sensory testing (light touch, vibration, pain, temperature), and motor system assessment.

Neuropathy was evaluated using:

Diabetic Neuropathy Symptom (DNS) Score- A score ≥1 indicated probable neuropathy

Michigan Neuropathy Screening Instrument (MNSI)- A score >2.5 was considered diagnostic for neuropathy

All patients underwent NCS using the RMS Aleron NCV machine for both sensory and motor nerves (peroneal, tibial, sural, median, and ulnar).

Laboratory investigations included:

- Fasting and postprandial blood sugar levels
- HbA1c
- Lipid profile
- Serum creatinine
- Spot urine for albumin-creatinine ratio (UACR)
- Fundus examination to assess diabetic retinopathy

Statistical Analysis- Data were compiled and analyzed using descriptive and inferential statistical methods. Continuous variables were expressed as mean±standard deviation (SD). Associations were tested using chi-square and t-tests. A p-value<0.05 was considered statistically significant.

Ethical Clearance- Prior approval was obtained from the Institutional Ethical Committee. All participants were informed about the study, and written consent was obtained.

RESULTS

The study included 95 T2DM patients (mean age: 54.6±8.9 years; 60% male). Most had diabetes for over five years (69.5%) and poor glycemic control (HbA1c >8% in 48.4%). Over half had BMI ≥25 kg/m² (55.8%). Microalbuminuria and retinopathy were present in 40% and 43.1% of patients, respectively, indicating notable microvascular involvement (Table 1).

doi: 10.21276/SSR-IIJLS.2025.11.3.43

Table 1: Baseline Characteristics of the Study Population (n = 95)

Parameter	Value / Range	Frequency (n)	Percentage (%)
Age (years)	35–70	–	Mean±SD: 54.6±8.9
Gender	Male	57	60
	Female	38	40
Duration of Diabetes	<5 years	29	30.5
	5–10 years	36	37.9
	>10 years	30	31.6
HbA1c Level	<7%	21	22.1
	7–8%	28	29.5
	>8%	46	48.4
BMI >25 kg/m²	–	53	55.8
Microalbuminuria Present	–	38	40
Retinopathy Present	–	41	43.1

Table 2 presents the clinical features and symptom scores related to diabetic peripheral neuropathy. Tingling sensation and burning feet were the most common symptoms. DNS ≥1 was noted in over 70%, and MNSI >2.5 in 61%, indicating a high clinical burden of neuropathy. Abnormal monofilament and vibration sense were also common.

Table 2: Distribution of Neuropathy Symptoms and Scores

Clinical Feature	Present (n)	Percentage (%)
Tingling Sensation	64	67.4
Burning Feet	52	54.7
Loss of Vibration Sense	46	48.4
Diminished Light Touch	41	43.2
DNS Score ≥1	68	71.6
MNSI Score >2.5	58	61.1
Ankle Reflex Absent	47	49.5
Positive Monofilament Test	45	47.4

Table 3 highlights the nerve conduction study findings. Sural and tibial nerves were most frequently affected. More than 50% of patients had absent or abnormal conduction in these nerves. Median and ulnar nerves were relatively spared. This pattern reflects the typical distal symmetric sensorimotor neuropathy seen in diabetes.

Table 3: Nerve Conduction Study (NCS) Findings

Nerve	Normal (%)	Abnormal (%)	Absent (%)	Most Common Abnormality
Tibial (Motor)	28 (29.5)	15 (15.8)	52 (54.7)	Reduced amplitude
Sural (Sensory)	25 (26.3)	7 (7.4)	63 (66.3)	Absent conduction
Plantar (Sensory)	38 (40.0)	16 (16.8)	41 (43.2)	Delayed latency
Median (Motor)	54 (56.8)	19 (20.0)	22 (23.2)	Reduced velocity
Ulnar (Motor)	61 (64.2)	12 (12.6)	22 (23.2)	Borderline findings

doi: 10.21276/SSR-IIJLS.2025.11.3.43

Table 4 outlines the correlation between neuropathy and other complications. A statistically significant association was observed between neuropathy and the presence of microalbuminuria, retinopathy, high HbA1c, and longer duration of diabetes.

Table 4: Correlation of Neuropathy with Retinopathy and Microalbuminuria

Parameter	Neuropathy Present (%) (n = 68)	Neuropathy Absent (%) (n = 27)	p-value
Microalbuminuria	33 (48.5)	5 (18.5)	<0.05
Retinopathy	36 (52.9)	5 (18.5)	<0.05
HbA1c >8%	42 (61.8)	4 (14.8)	<0.001
Duration >10 years	28 (41.2)	2 (7.4)	<0.001

Fig. 1 shows that neuropathy prevalence increases with the duration of diabetes. Among patients with <5 years of diabetes, neuropathy was seen in 34%; in 5–10 years, it increased to 61%; and in >10 years duration, 93% of patients showed neuropathic signs.

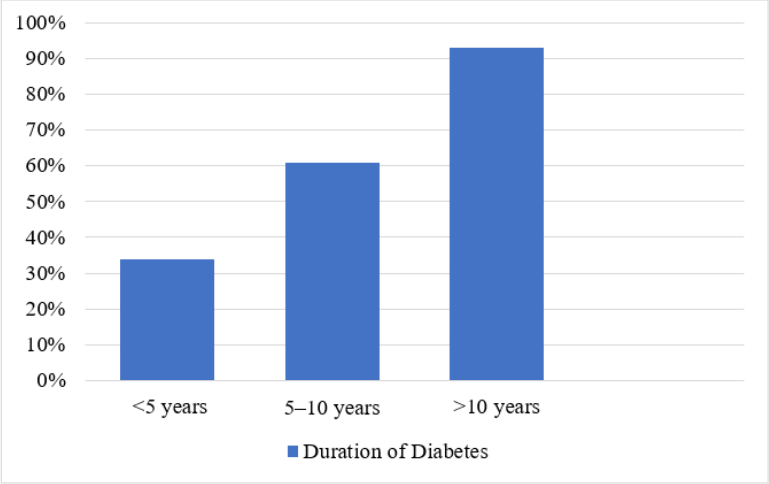

Fig. 1: Prevalence of Neuropathy by Duration of Diabetes

Fig. 2 represents the percentage distribution of abnormal nerve conduction in different nerves. The sural nerve was most affected (66%), followed by the tibial (55%), plantar (43%), median (23%), and ulnar nerves (23%).

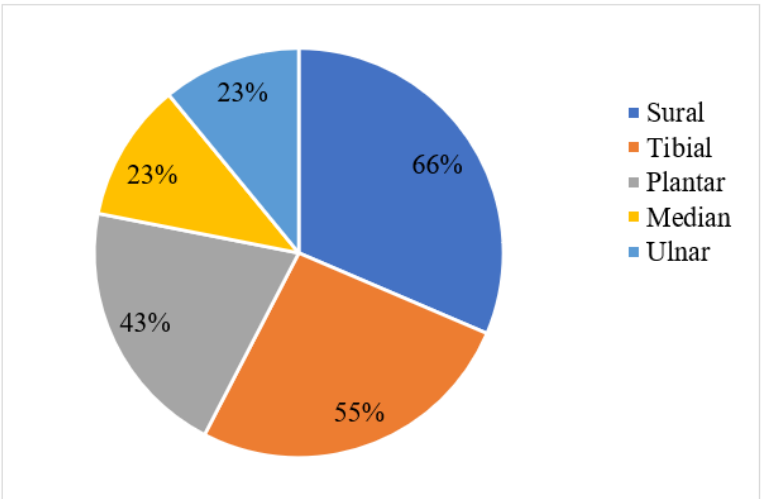

Fig. 2: Distribution of Abnormal Nerve Involvement in NCS

doi: 10.21276/SSR-IIJLS.2025.11.3.43

DISCUSSION

Diabetic peripheral neuropathy (DPN) is one of the earliest and most prevalent microvascular complications in type 2 diabetes. The present study confirms that DPN is highly prevalent, particularly in individuals with poor glycemic control and longer disease duration. The significant association between higher HbA1c and neuropathy reinforces the importance of glycemic optimization in preventing neural damage [10].

Clinical tools such as DNS and MNSI scores showed utility in identifying patients with symptomatic neuropathy. However, a subset of patients had abnormal nerve conduction despite the absence of symptoms, suggesting the presence of subclinical neuropathy. This underscores the importance of NCS in early diagnosis and comprehensive evaluation [11].

Our study identified sural and tibial nerves as the most frequently involved, aligning with the length-dependent dying-back axonopathy hypothesis of DPN. Electrophysiological abnormalities such as delayed latency and reduced amplitude in these nerves support findings from prior studies demonstrating the early involvement of sensory fibers [12,13].

Additionally, a strong correlation was observed between neuropathy and both microalbuminuria and retinopathy. These results suggest a shared pathophysiological pathway involving chronic hyperglycemia-induced microvascular injury [14]. Microalbuminuria, traditionally considered a renal marker, may serve as an early surrogate for broader microangiopathic damage, including neural and retinal tissues [15].

The association between fundoscopic changes and peripheral nerve abnormalities is supported by earlier research showing that patients with retinopathy often harbor concurrent neuropathy. This triad—neuropathy, nephropathy, and retinopathy—may reflect systemic microvascular compromise rather than isolated organ damage [16,17].

Longer duration of diabetes emerged as an independent risk factor for neuropathy in our study. This aligns with the natural progression of DPN and supports longitudinal studies demonstrating cumulative glycemic insult as a key contributor to nerve degeneration [18].

Electrophysiological screening has been shown to detect changes even in asymptomatic patients, as confirmed in this study. These findings emphasize the need for early and routine NCS evaluation in T2DM, especially in patients with suboptimal glycemic control or coexisting microvascular complications [19,20].

In India, underutilization of NCS and lack of emphasis on combined screening strategies in current guidelines leave many cases undiagnosed until complications occur. Our study contributes to the growing body of evidence advocating for integrated screening of neuropathy, retinopathy, and nephropathy to reduce long-term disability and healthcare burden [21,22].

CONCLUSIONS

Diabetic peripheral neuropathy is a highly prevalent complication in type 2 diabetes mellitus, often underdiagnosed in its early stages. This study demonstrates a significant correlation between neuropathy and other microvascular complications, such as retinopathy and microalbuminuria. Sural and tibial nerves were most frequently affected. Higher HbA1c and longer diabetes duration were strong predictors of neuropathy. Electrophysiological studies should be incorporated alongside clinical tools for early detection and management. Integrated screening of microvascular complications is essential for preventing progression and improving patient outcomes.

CONTRIBUTION OF AUTHORS

Research concept- Kamala Kant Bhoi, Naresh Verma
Research design- Kamala Kant Bhoi
Supervision- Kamala Kant Bhoi, Deepak Jaiswal
Materials- Kamala Kant Bhoi
Data collection- Kamala Kant Bhoi, Naresh Verma
Data analysis and interpretation- Kamala Kant Bhoi
Literature search- Kamala Kant Bhoi
Writing article- Kamala Kant Bhoi, Deepak Jaiswal
Critical review- Kamala Kant Bhoi
Article editing- Kamala Kant Bhoi
Final approval- Kamala Kant Bhoi, Deepak Jaiswal

REFERENCES

[1] World Health Organization. Definition and diagnosis of diabetes mellitus and intermediate hyperglycemia: report of a WHO/IDF consultation. Geneva: WHO Press; 2006.
[2] International Diabetes Federation. IDF Diabetes Atlas, 10th ed. Brussels, Belgium: IDF; 2021.
[3] American Diabetes Association. Microvascular complications and foot care: Standards of Medical

doi: 10.21276/SSR-IIJLS.2025.11.3.43

Care in Diabetes—2022. Diabetes Care, 2022; 45(Suppl 1): S185–S94.

[4] Research Society for the Study of Diabetes in India (RSSDI). Clinical Practice Recommendations for the Management of Type 2 Diabetes Mellitus 2022. Int J Diabetes Dev Ctries, 2022; 42(Suppl 1): S1–S170.

[5] Boulton AJM, Vinik AI, Arezzo JC, et al. Diabetic neuropathies: A statement by the American Diabetes Association. Diabetes Care, 2005; 28(4): 956–62.

[6] Brownlee M. Biochemistry and molecular cell biology of diabetic complications. Nature, 2001; 414(6865): 813–20.

[7] Mogensen CE. Microalbuminuria predicts clinical proteinuria and early mortality in maturity-onset diabetes. N Engl J Med., 1994; 310(6): 356–60.

[8] Wilkinson CP, Ferris FL III, Klein RE, et al. Proposed international clinical diabetic retinopathy and diabetic macular edema disease severity scales. Ophthalmol., 2003; 110(9): 1677–82.

[9] England JD, Gronseth GS, Franklin G, et al. Practice parameter: evaluation of distal symmetric polyneuropathy. Neurol., 2009; 72(2): 177–84.

[10]Hamid MA, Ahmed SM, Mohammed MI, et al. Relationship between nerve conduction velocity and glycemic control in Sudanese patients with diabetic neuropathy. Sudan J Med Sci., 2021; 16(1): 53–60.

[11]Park JH, Lee JS, Yim HW, et al. Correlation between the Michigan Neuropathy Screening Instrument and nerve conduction studies in patients with diabetic neuropathy. J Clin Neurol., 2019; 15(2): 203–09.

[12]de Souza RJ, Pinto MM, Noronha RM. Nerve conduction abnormalities in asymptomatic diabetic patients: correlation with glycemic control and clinical features. Diabetol Metab Syndr., 2015; 7: 20.

[13]Arora S, Maiti R, Tandon OP. Electrophysiological assessment of peripheral neuropathy in type 2 diabetes mellitus. J Clin Diagn Res., 2018; 12(6): CC10–CC14.

[14]Su J, Yang X, Shao X, et al. HbA1c variability and diabetic peripheral neuropathy in type 2 diabetes: a retrospective study. J Diabetes Res., 2018; 2018: 1–7.

[15]Kaliaperumal R, Rao M, Krishnamurthy N, et al. A cross-sectional study on association of diabetic neuropathy with microalbuminuria and HbA1c in South Indian population. Int J Diabetes Dev Ctries, 2021; 41(3): 469–74.

[16]Sharma K, Prasad S. Association of microalbuminuria with diabetic retinopathy and neuropathy: A cross-sectional study. Indian J Clin Pract., 2020; 31(6): 510–14.

[17]Agarwal S, Singh A, Gupta S. Early detection of diabetic peripheral neuropathy using nerve conduction studies in asymptomatic patients. Indian J Endocrinol Metab., 2018; 22(6): 766–70.

[18]Pattni VI, Chouhan S, Makwana S. Impact of duration of diabetes on sural nerve conduction parameters in T2DM. Natl J Physiol Pharm Pharmacol., 2022; 12(9): 1432–36.

[19]Tung DD, Dung TV, Hieu NV. Electrophysiological evaluation of peripheral neuropathy in T2DM patients: a cross-sectional study in Vietnam. J Diabetes Res Clin Pract., 2023; 189: 110121.

[20]Haji K, Rezaei M, Shakeri R, et al. Association of nerve conduction velocity with clinical tendon reflexes in diabetic patients. J Diabetes Metab Disord., 2018; 17(1): 45–51.

[21]Patil M, Sharma M, Jain P. Demographic profile and clinical correlation with nerve conduction studies in diabetic neuropathy. Int J Res Med Sci., 2018; 6(9): 2930–34.

[22]RSSDI Guidelines. Clinical evidence gaps in neuropathy evaluation. In: RSSDI Clinical Practice Recommendations 2022. New Delhi: Jaypee Brothers Medical Publishers; 2022. pp. 95–97.