

CLINICAL FEATURES OF DIABETIC PERIPHERAL NEUROPATHY: A COMPARATIVE EVALUATION OF THE MICHIGAN NEUROPATHY SCREENING INSTRUMENT (MNSI) AND NERVE CONDUCTION STUDY (NCS) IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Background

Diabetic peripheral neuropathy (DPN) is among the most prevalent and disabling complications of type 2 diabetes mellitus (T2DM). Accurate early diagnosis remains a challenge due to overlapping clinical presentations and limited accessibility of electrophysiological testing.

Objective

To evaluate the association between the Michigan Neuropathy Screening Instrument (MNSI) and nerve conduction studies (NCS) in diagnosing DPN and to assess the diagnostic utility of MNSI as a screening tool in a tertiary care setting.

Methods

A cross-sectional observational study was conducted over 18 months (January 2025–June 2026) at Sree Balaji Medical College & Hospital, Chennai. One hundred patients aged 18–65 years with symptomatic T2DM were enrolled using purposive sampling. All participants underwent MNSI assessment and NCS evaluation of median, ulnar, tibial, and peroneal nerves. Statistical analysis included Pearson correlation, sensitivity/specificity analysis, and kappa agreement testing.

Results

The mean age was 40.92 ± 14.05 years and mean HbA1c was $8.13 \pm 1.27\%$. Neuropathy prevalence was 71% by MNSI and 85% by NCS. Median sensory conduction velocity was significantly reduced in the neuropathy group (47.86 vs. 52.69 m/s; $p < 0.001$). MNSI correlated significantly with median ($r = 0.268$, $p = 0.007$) and ulnar ($r = 0.225$, $p = 0.024$) sensory latencies. Diagnostic accuracy of MNSI was 60%, with sensitivity 68.2%, specificity 13.3%, PPV 81.7%, and kappa -0.133 .

Conclusion

MNSI is an effective, low-cost screening tool for DPN with high PPV but limited specificity. NCS remains the gold standard and is essential for confirmatory diagnosis. A stepwise approach—MNSI screening followed by NCS confirmation—is recommended for optimal clinical management.

Keywords: Diabetic peripheral neuropathy; Michigan Neuropathy Screening Instrument; Nerve conduction study; Type 2 diabetes mellitus; Screening; Electrophysiology.

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INTRODUCTION

Diabetes mellitus (DM) is one of the foremost public health challenges of the 21st century, affecting approximately 463 million adults globally in 2019—a figure projected to reach 700 million by 2045 (IDF, 2019). India shoulders a disproportionately large share of this burden, driven by urbanisation, sedentary behaviour, and dietary transition. Among its many chronic complications, diabetic peripheral neuropathy (DPN) is the most prevalent, affecting up to 50% of individuals with long-standing disease.

DPN, particularly the distal symmetrical polyneuropathy subtype, results from progressive damage to peripheral sensory and motor nerves. Clinically, patients present

with numbness, tingling, burning sensations, and neuropathic pain in a stocking-glove distribution. Motor involvement leads to weakness and falls; loss of protective sensation predisposes to foot ulcers, which precede 85% of diabetes-related amputations. Despite this burden, DPN remains underdiagnosed, partly because no single universally accepted diagnostic test exists. Two primary modalities are used in clinical practice. The Michigan Neuropathy Screening Instrument (MNSI)—comprising a patient questionnaire and a structured physical examination—is simple, cost-effective, and widely deployable in outpatient settings. Nerve conduction studies (NCS), which provide objective, quantitative assessment of nerve conduction velocity, amplitude, and latency, are considered the

electrophysiological gold standard but are costly, equipment-dependent, and often reserved for specialist referral. Establishing the diagnostic relationship between these two tools is therefore clinically important, particularly in high-burden tertiary care environments like India.

This study was designed to evaluate the association between MNSI and NCS in diagnosing DPN, to determine the diagnostic value of MNSI relative to NCS, and to describe the clinical and electrophysiological profile of DPN in a tertiary care cohort.

MATERIALS AND METHODS

Study Design and Setting

A cross-sectional observational study was conducted in the Department of Neurology, Sree Balaji Medical College & Hospital, Chennai, over an 18-month period from January 2025 to June 2026. Patients were recruited from both outpatient and inpatient services of Neurology and General Medicine departments. Ethical clearance was obtained from the Institutional Ethics Committee (IEC) prior to commencement, and written informed consent was obtained from all participants.

Study participants

One hundred adult patients (aged 18–65 years) with diagnosed T2DM and symptoms suggestive of peripheral neuropathy (numbness, tingling, burning, or pain in extremities) were enrolled using purposive consecutive sampling. Participants were required to have an MNSI score ≥ 1 . Exclusion criteria included type 1 diabetes, non-diabetic neuropathies (hereditary, traumatic, Guillain-Barré syndrome, alcohol-related), epilepsy, contraindications to NCS, diabetes duration < 1 year, and severe cognitive impairment.

Clinical Assessment — MNSI

The MNSI was administered in two parts: (i) a 15-item patient-reported symptom questionnaire and (ii) a structured physical examination evaluating foot appearance, ulceration, vibration perception (128 Hz tuning fork at the first metatarsal head), and ankle reflexes. Neuropathy was classified as present when the total MNSI score was ≥ 2.5 , consistent with established validation cut-offs.

Electrophysiological Assessment — NCS

NCS was performed by a trained neurophysiologist using a standardised protocol. The following nerves were evaluated: median sensory (sensory nerve action potential [SNAP] amplitude, conduction velocity [CV], and latency), ulnar sensory (SNAP amplitude, CV, latency), tibial motor (compound muscle action potential [CMAP] amplitude, CV, latency), and peroneal motor (CMAP amplitude, CV, latency). Neuropathy was defined by abnormal values in two or more nerve parameters based on laboratory reference ranges, consistent with established electrodiagnostic criteria.

Statistical Analysis

Data were analysed using SPSS version 26.0. Continuous variables are expressed as mean \pm standard deviation (SD). Pearson's correlation coefficient was used to assess

relationships between MNSI scores and NCS parameters. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated using NCS as the reference standard. Agreement between MNSI and NCS was evaluated using Cohen's kappa. Group comparisons used independent t-tests and chi-square tests, as appropriate. A p-value < 0.05 was considered statistically significant.

RESULTS

Demographic and Clinical Characteristics

The cohort comprised 100 patients, of whom 60 (60%) were male. Mean age was 40.92 ± 14.05 years and mean diabetes duration was 10.08 ± 6.64 years. Glycaemic control was suboptimal, with a mean HbA1c of $8.13 \pm 1.27\%$, and the mean BMI was 26.63 ± 3.15 kg/m². The overall prevalence of neuropathy was 71% by MNSI criteria and 85% by NCS, indicating a substantial proportion of subclinically detected cases.

Table 1: Demographic and Clinical Characteristics of the Study Population (n=100)

Variable	Value
Age (years), mean \pm SD	40.92 \pm 14.05
Diabetes duration (years), mean \pm SD	10.08 \pm 6.64
HbA1c (%), mean \pm SD	8.13 \pm 1.27
BMI (kg/m ²), mean \pm SD	26.63 \pm 3.15
Male, n (%)	60 (60.0%)
Female, n (%)	40 (40.0%)
MNSI neuropathy positive, n (%)	71 (71.0%)
NCS neuropathy positive, n (%)	85 (85.0%)

MNSI Score Distribution

The mean MNSI score was 4.23 ± 3.25 (median 4.00; IQR 1.00–7.00; range 0–10). Seventy-one percent of participants met the MNSI threshold for neuropathy. The wide score distribution reflects the heterogeneous clinical severity in a symptomatic tertiary care population.

Table 2: Distribution of MNSI Scores

Statistic	Value
Mean	4.23
Standard deviation	3.25
Minimum	0.00
25th percentile	1.00
Median	4.00
75th percentile	7.00
Maximum	10.00
Neuropathy positive (≥ 2.5), n (%)	71 (71.0%)

NCS Parameters by Neuropathy Status

Statistically significant reductions in conduction velocity were observed in the neuropathy group for the median sensory nerve (47.86 vs. 52.69 m/s; $p < 0.001$), tibial motor nerve (41.38 vs. 45.54 m/s; $p = 0.001$), and peroneal motor nerve (40.51 vs. 43.05 m/s; $p = 0.004$). Amplitude and latency differences were generally not statistically significant, indicating that conduction velocity is the most sensitive electrophysiological discriminator in this cohort.

Table 3: NCS Parameters by Neuropathy Status (NCS Normal vs. NCS Neuropathy)

Parameter	Normal (n=15)	Neuropathy (n=85)	p-value
Median SNAP Amplitude (μ V)	20.93 \pm 5.30	18.55 \pm 6.94	0.139
Median SNAP CV (m/s)	52.69 \pm 2.61	47.86 \pm 5.58	<0.001*
Median SNAP Latency (ms)	3.53 \pm 0.45	3.40 \pm 0.36	0.304
Ulnar SNAP Amplitude (μ V)	17.89 \pm 4.85	17.00 \pm 6.11	0.535
Ulnar SNAP CV (m/s)	48.53 \pm 3.75	49.04 \pm 3.94	0.632
Ulnar SNAP Latency (ms)	3.15 \pm 0.33	3.25 \pm 0.34	0.277
Tibial CMAP Amplitude (mV)	7.67 \pm 2.19	6.49 \pm 2.70	0.077
Tibial CMAP CV (m/s)	45.54 \pm 3.74	41.38 \pm 3.79	0.001*
Tibial CMAP Latency (ms)	4.36 \pm 0.69	4.46 \pm 0.68	0.630
Peroneal CMAP Amplitude (mV)	5.04 \pm 1.84	5.67 \pm 1.92	0.238
Peroneal CMAP CV (m/s)	43.05 \pm 2.64	40.51 \pm 3.72	0.004*
Peroneal CMAP Latency (ms)	4.35 \pm 0.63	4.37 \pm 0.60	0.891

* $p < 0.05$ statistically significant. CV = conduction velocity; SNAP = sensory nerve action potential; CMAP = compound muscle action potential.

Correlation of MNSI Score with NCS Parameters

Pearson correlation analysis revealed statistically significant positive correlations between MNSI scores and median sensory latency ($r = 0.268$, $p = 0.007$) and ulnar sensory latency ($r = 0.225$, $p = 0.024$). All other NCS parameters showed weak, non-significant correlations, suggesting that MNSI captures certain aspects of latency-related nerve dysfunction but does not broadly reflect electrophysiological severity.

Table 4: Pearson Correlation of MNSI Score with NCS Parameters

NCS Parameter	Pearson r	p-value
Median SNAP Amplitude (μ V)	0.086	0.393
Median SNAP CV (m/s)	0.101	0.316
Median SNAP Latency (ms)	0.268	0.007*
Ulnar SNAP Amplitude (μ V)	-0.041	0.685
Ulnar SNAP CV (m/s)	-0.019	0.851
Ulnar SNAP Latency (ms)	0.225	0.024*
Tibial CMAP Amplitude (mV)	-0.100	0.324
Tibial CMAP CV (m/s)	0.016	0.874
Tibial CMAP Latency (ms)	0.028	0.783
Peroneal CMAP Amplitude (mV)	-0.021	0.836
Peroneal CMAP CV (m/s)	0.092	0.361
Peroneal CMAP Latency (ms)	-0.135	0.180

* $p < 0.05$ statistically significant

Diagnostic Agreement Between MNSI and NCS

With NCS as the reference standard, MNSI demonstrated a sensitivity of 68.2% and specificity of 13.3%, indicating moderate sensitivity but poor specificity. The PPV was 81.7%, confirming that a positive MNSI result is likely to represent true neuropathy; however, the NPV was only 6.9%, reflecting the tool's limited ability to exclude disease. Overall accuracy was 60% and the kappa coefficient was -0.133, indicating poor agreement beyond chance.

Table 5: Diagnostic Performance of MNSI Relative to NCS (Reference Standard)

Metric	Value
True Positives (TP)	58
False Positives (FP)	13
False Negatives (FN)	27
True Negatives (TN)	2
Sensitivity	68.2%
Specificity	13.3%
Positive Predictive Value (PPV)	81.7%
Negative Predictive Value (NPV)	6.9%
Overall Accuracy	60.0%
Cohen's Kappa	-0.133 (poor agreement)

Neuropathy Prevalence by Clinical Subgroups

Neuropathy prevalence was high across all age groups (18–44 years: 87.1%; 45–54 years: 78.6%; 55–65 years: 83.3%), with the youngest cohort having the greatest prevalence—a finding that warrants attention. Prevalence increased with diabetes duration and peaked in the 6–10-year group (95.0%), declining marginally in those with >10 years (80.4%). Across HbA1c quartiles, prevalence remained elevated throughout (range: 76.0–91.7%), with the highest in Q3. None of these subgroup differences reached statistical significance ($p>0.05$), likely reflecting sample size constraints.

Table 6: Neuropathy Prevalence by Age Group, Diabetes Duration, and HbA1c Quartile

Subgroup	Category	Neuropathy (%)
Age group (years)	18–44	87.1%
	45–54	78.6%
	55–65	83.3%
Diabetes duration (years)	≤5	85.3%
	6–10	95.0%
	>10	80.4%
HbA1c Quartile	Q1 (lowest)	88.0%
	Q2	84.6%
	Q3	91.7%
	Q4 (highest)	76.0%

DISCUSSION

This cross-sectional study evaluated the diagnostic relationship between MNSI and NCS in 100 symptomatic T2DM patients attending a tertiary care neurological centre. The high overall prevalence of DPN—85% by NCS and 71% by MNSI—is consistent with the selection of symptomatic outpatients with long-standing, poorly controlled diabetes and is broadly comparable to hospital-based cohorts in the literature. Population-based studies in South India (Kumapatla et al., 2013) have reported lower rates (~26%), reflecting the healthier spectrum of community samples, whereas tertiary referral cohorts routinely detect rates of 44–85% (Perveen et al., 2024; Dyck et al., 1993).

The 14-percentage-point gap between NCS (85%) and MNSI (71%) detection rates is clinically significant. It reaffirms the well-established concept that electrophysiological abnormalities precede clinical symptomatology in diabetic neuropathy—a finding consistently reported in long-term prospective studies (Dyck et al., 1993; Herman et al., 2012). Subclinical neuropathy detected only by NCS represents a window of opportunity for preventive intervention before irreversible large-fiber damage occurs.

The observed reduction in conduction velocity across median, tibial, and peroneal nerves in the neuropathy group reflects the combined effects of segmental demyelination and axonal degeneration—the hallmarks of chronic diabetic nerve injury. The fact that amplitude differences were not significant may indicate a predominantly demyelinating process in this relatively younger cohort, in contrast to the axonal loss that dominates in more advanced disease.

MNSI showed a weak but statistically significant correlation with sensory latency parameters (median: $r=0.268$; ulnar: $r=0.225$), in keeping with previous reports of moderate MNSI–NCS correlations (Fateh et al., 2015; Park et al., 2018). The absence of significant correlations with amplitude and conduction velocity parameters suggests that MNSI is more sensitive to large-fiber latency dysfunction than to the full electrophysiological spectrum of neuropathy. This likely reflects the MNSI's dependence on vibration sense and ankle reflexes—tests mediated by large, myelinated Aβ-fibers whose slowing is captured by latency measures.

The diagnostic performance profile—high PPV (81.7%) but very low specificity (13.3%)—positions MNSI optimally as a screening tool. A high PPV means that a positive MNSI result is highly likely to correspond to true NCS-confirmed neuropathy, making it valuable for triage in busy outpatient settings. The low NPV and poor kappa, however, confirm that MNSI cannot safely exclude neuropathy and should not be used as a standalone diagnostic instrument. This aligns with recommendations from recent systematic reviews (Al-Khafaji et al., 2025) that advocate an integrated diagnostic algorithm.

Notably, neuropathy prevalence was highest in the youngest age group (18–44 years: 87.1%), contrasting with traditional assumptions of predominant geriatric onset. This finding may reflect earlier onset of T2DM in this cohort, chronic poor glycaemic control, and possible inclusion bias toward symptomatic younger patients. The gradual increase in prevalence with diabetes duration, peaking at 6–10 years (95%), then declining at >10 years (80.4%), likely represents a survivor bias and disease-stage sampling effect rather than a true biological attenuation.

Several limitations deserve acknowledgement. The cross-sectional design precludes causal inference and longitudinal tracking of neuropathy progression. The sample size ($n=100$), though adequate for primary analysis, limits statistical power for subgroup comparisons. Small-fiber neuropathy—which NCS cannot assess—was not evaluated, potentially underestimating total DPN burden. The single-centre, tertiary care setting reduces generalisability to primary care or community populations.

CONCLUSIONS

Diabetic peripheral neuropathy is highly prevalent among patients with T2DM attending tertiary care facilities, with electrophysiological testing identifying a substantially greater proportion of cases than clinical screening alone.

MNSI is a practical, non-invasive, and cost-effective first-line screening tool with moderate sensitivity and high PPV, but its poor specificity and very low NPV preclude its use as a standalone diagnostic instrument. NCS remains indispensable for confirmatory diagnosis, particularly in detecting subclinical neuropathy. The weak-to-moderate correlation between MNSI and NCS parameters indicates that these tools are complementary rather than interchangeable, evaluating different dimensions of nerve dysfunction.

Based on these findings, we recommend a stepwise diagnostic protocol: (1) routine MNSI screening in all T2DM patients at outpatient visits; (2) referral for NCS in all MNSI-positive cases; (3) early intensification of glycaemic control, lipid management, and foot care in all confirmed neuropathy cases; and (4) periodic reassessment regardless of initial screening outcome, given the high subclinical burden. Larger, multicentric, longitudinal studies—incorporating small-fiber assessment—are warranted to validate these findings and refine diagnostic thresholds for diverse Indian populations.

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Ethics Approval: Approved by the Institutional Ethics Committee (IEC), Sree Balaji Medical College & Hospital, Chennai. All participants provided written informed consent.

Data Availability: De-identified data are available on reasonable request to the corresponding author.

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