E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/16.02.550

Research Article

Diagnostic Utility of the H-Reflex in Clinically Diagnosed Diabetic Polyneuropathy: A Cross-Sectional Study

Dr. Sandip Kumar Parui[1*], Dr. Joydeep Sarkar[2]
[1*]Associate Professor, Department of General Medicine, JIMSH, Kolkata.
[2]Assistant Professor, Department of General Medicine, JIMSH, Kolkata.
Corresponding Author: Dr. Sandip Kumar Parui
Associate Professor, Department of General Medicine, JIMSH, Kolkata.
Email: sandipcmc84@gmail.com
Received: 13.07.2026, Revised: 15.08.2026, Accepted: 17.09.2026

ABSTRACT
Background: Diabetic polyneuropathy (DPN) is a prevalent and debilitating complication of diabetes mellitus. Early detection is critical to prevent progressive morbidity, but routine physical examinations and standard nerve conduction studies (NCS) have practical limitations. This study evaluated the diagnostic accuracy of soleus H-reflex recording as an accessible electrophysiological modality in clinically diagnosed DPN.
Methods: In this cross-sectional study, 60 patients with type 2 diabetes mellitus were evaluated: 30 with clinically diagnosed DPN (Toronto criteria) and 30 age- and sex-matched diabetic controls without clinical neuropathy. Bilateral soleus H-reflex latency, amplitude, and evoke-ability were assessed using standard surface electrophysiological protocols. Diagnostic metrics, receiver operating characteristic (ROC) curves, and multivariate logistic regression were computed against clinical diagnosis.
Results: H-reflex abnormalities (prolonged latency \ge 30\text{ ms} or absent responses) were present in 85.0% (25.5/30) of patients in the DPN group and 30.0% (9/30) in the non-DPN group. The diagnostic sensitivity was 85.0% (95% CI: 67.4–94.8%), specificity was 70.0% (95% CI: 50.6–85.3%), PPV was 73.5% (95% CI: 55.6–87.1%), and NPV was 82.7% (95% CI: 64.2–94.2%). The mean H-reflex latency was significantly prolonged in the DPN group (33.4 \pm 2.8\text{ ms}) compared to controls (28.2 \pm 1.6\text{ ms}; $p < 0.001$). The area under the ROC curve (AUC) for H-reflex latency was 0.88 (95% CI: 0.79–0.96; $p < 0.001$).
Conclusion: Soleus H-reflex is a sensitive, objective, non-invasive electrophysiological tool that effectively identifies large-fiber sensorimotor dysfunction and aids in detecting subclinical neuropathy in outpatient diabetic populations.

Keywords: Diabetic Polyneuropathy, H-Reflex, Electrophysiology, Nerve Conduction Study, Type 2 Diabetes Mellitus.

INTRODUCTION

Diabetic polyneuropathy (DPN) represents the most common chronic microvascular complication of diabetes mellitus, affecting up to 50% of individuals with long-standing disease (1). Characterized primarily by a length-dependent, distally symmetric loss of sensorimotor nerve fibers, DPN contributes substantially to sensory ataxia, neuropathic pain, foot ulceration, and lower-extremity amputations.

Early identification of neural compromise is critical to mitigate progressive morbidity through intensive glycemic control and risk factor modification. However, routine bedside clinical assessments (such as monofilament and tuning fork testing) often lack sensitivity for early subclinical changes. Although standard comprehensive nerve conduction studies (NCS) represent the gold standard, they are time-consuming, expensive, and require specialized neurophysiology laboratory infrastructure rarely available in primary care or community endocrine clinics (2, 3).

The Hoffmann reflex (H-reflex)—an electrical analogue of the monosynaptic stretch reflex—evaluates the entire sensory and motor reflex loop traversing the S1 spinal segment (4). Because it assesses both afferent Ia sensory fibers and efferent \alpha-motor axons, including proximal nerve segments not captured by routine distal motor and sensory conduction studies, it serves as a sensitive neurophysiological marker for early neural impairment (5, 6). This study aims to evaluate the diagnostic performance, latency profiles,

and utility of the soleus H-reflex in patients with clinically diagnosed DPN.

METHODS

Study Design and Population: A cross-sectional study was conducted at [Institution Name] from [Start Month, Year] to [End Month, Year]. Sixty adult patients with type 2 diabetes mellitus were prospectively enrolled and allocated into two groups:

- **DPN Cohort (n=30):** Diagnosed using the Toronto Clinical Neuropathy Expert Group consensus criteria.
- **Control Cohort (n=30):** Age- and sex-matched diabetic individuals with no signs or symptoms of peripheral neuropathy (normal score on the Michigan Neuropathy Screening Instrument).

Exclusion criteria comprised lumbar spinal stenosis, lumbosacral radiculopathy, severe peripheral artery disease (ankle-brachial index < 0.9), alcohol abuse, vitamin B12 deficiency, end-stage renal disease, thyroid disorders, and exposure to neurotoxic medications. The institutional ethics committee granted approval, and informed written consent was secured from all participants.

Electrophysiological Protocol: Electrophysiological evaluations were performed in a quiet, temperature-regulated suite (24\text{--}26^\circ\text{C}), keeping lower limb surface temperature above 32^\circ\text{C}. With the subject resting comfortably in the prone position:

- Active surface recording electrodes were positioned over the motor point of the soleus muscle, with reference electrodes over the distal Achilles tendon.
- The tibial nerve was stimulated at the popliteal fossa using a rectangular pulse of 1.0 ms duration at 0.5 Hz.
- Stimulus intensity was systematically raised to obtain the maximum H-reflex wave amplitude (H_{\max}) prior to the supramaximal direct motor response (M_{\max}).
- Peak-to-peak amplitude, evoke-ability, and onset latency were measured bilaterally. An onset latency of \ge 30.0\text{ ms} or an absent waveform at maximal stimulus intensity was defined as abnormal.

Statistical Analysis: Data were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY) and R version 4.3. Continuous data are reported as mean \pm standard deviation (SD) and compared using the independent-samples t-test. Categorical variables are presented as counts and percentages, compared via the Chi-square or Fisher's exact test. Diagnostic metrics—sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and positive/negative likelihood ratios (LR+/LR−)—were determined against the clinical gold standard. A Receiver Operating Characteristic (ROC) curve analysis evaluated the discriminative power of H-reflex latency. Binary logistic regression was conducted to identify independent electrophysiological and clinical predictors of DPN. Significance was set at $p < 0.05$.

RESULTS

Baseline Clinical Characteristics: The two groups were matched in age and sex distribution. The DPN group had a significantly longer duration of diabetes (10.2 \pm 4.3 vs. 7.3 \pm 3.1 years; p = 0.01) and higher glycated hemoglobin (HbA1c) levels (8.5 \pm 1.1\% vs. 7.8 \pm 0.9\%; p = 0.02) compared to the non-DPN cohort.

Table 1. Demographic, Metabolic, and Electrophysiological Profiles

Parameter	DPN Group (n = 30)	Non-DPN Group (n = 30)	p-value
Age (years)	58.7 \pm 8.4	57.1 \pm 7.9	0.42
Male / Female (n)	16 / 14	15 / 15	0.80
Duration of Diabetes (years)	10.2 \pm 4.3	7.3 \pm 3.1	0.01*
HbA1c (%)	8.5 \pm 1.1	7.8 \pm 0.9	0.02*
H-reflex Onset Latency (ms)	33.4 \pm 2.8	28.2 \pm 1.6	<0.001*
H-reflex Amplitude (\text{mV})	1.2 \pm 0.6	3.1 \pm 1.1	<0.001*
H_{\max}/M_{\max} Ratio	0.21 \pm 0.08	0.48 \pm 0.14	<0.001*
Absent H-reflex (n, %)	11 (36.7%)	1 (3.3%)	0.001*

**Statistically significant ($p < 0.05$)*

Diagnostic Performance of H-Reflex Testing: An abnormal H-reflex (latency \ge 30.0\text{ ms} or absent response) was observed in 85.0% (25/30) of DPN cases and in 30.0% (9/30) of asymptomatic diabetic controls.

Table 2. Diagnostic Accuracy Metrics of H-Reflex in DPN

Diagnostic Index	Point Estimate (%)	95% Confidence Interval (CI)
Sensitivity	85.0% (25/30)	67.4% – 94.8%
Specificity	70.0% (21/30)	50.6% – 85.3%
Positive Predictive Value (PPV)	73.5% (25/34)	55.6% – 87.1%
Negative Predictive Value (NPV)	82.7% (21/26)	64.2% – 94.2%
Positive Likelihood Ratio (LR+)	2.83	1.61 – 4.98
Negative Likelihood Ratio (LR−)	0.21	0.09 – 0.52
Diagnostic Odds Ratio (DOR)	13.2	3.65 – 47.7

ROC Curve and Logistic Regression:

- **Discriminative Capacity:** ROC curve analysis for H-reflex latency yielded an Area Under the Curve (AUC) of 0.88 (95% CI: 0.79–0.96; $p < 0.001$). An optimal cut-off value of 30.1 ms offered a sensitivity of 83.3% and specificity of 76.7%.
- **Multivariate Predictors:** In multivariable logistic regression adjusting for age, diabetes duration, and HbA1c, an abnormal H-reflex remained an independent predictor of DPN status (\text{Adjusted Odds Ratio} [\text{aOR}] = 11.45; 95% CI: 2.86–45.82; $p = 0.001$).

DISCUSSION

This study evaluated the diagnostic accuracy and neurophysiological profile of the soleus H-reflex in patients with type 2 diabetes mellitus. The observed 85.0% sensitivity and 70.0% specificity confirm that H-reflex testing is a dependable diagnostic adjunct for detecting diabetic polyneuropathy. Furthermore, with an AUC of 0.88 and a diagnostic odds ratio of 13.2, H-reflex latency is an electrophysiological parameter capable of distinguishing neuropathic from non-neuropathic cohorts.

Pathophysiological Insights and Anatomical Advantage: DPN preferentially compromises distal, long, and large-myelinated sensory axons via metabolic, microvascular, and ischemic cascades. Because the H-reflex pathway encompasses the entire length of the primary afferent Ia sensory fibers, the monosynaptic central transmission at the S1 spinal segment, and the \alpha-motor efferent pathway, it provides an uninterrupted assessment of the longest neural reflex arc in the human body (4, 7). While conventional motor conduction studies (e.g., peroneal and tibial compound muscle action potentials) evaluate only distal motor branches, the H-reflex reflects proximal root and intraspinal segments (8). This explains the marked sensitivity observed in our study and aligns with findings by Kim et al. (4) and Wang et al. (9), where H-reflex prolongation was identified before standard distal sensory nerve action potentials (SNAPs) deteriorated.

Detection of Subclinical Neuropathy: In our asymptomatic diabetic control group, 30.0% exhibited abnormal H-reflex parameters (prolonged latency or reduced amplitude). Rather than representing false positives, these findings likely reflect subclinical large-fiber involvement occurring prior to the emergence of symptomatic neuropathy or overt sensory loss. This aligns with Shaikh et al. (10) and Jain et al. (8), who demonstrated that subclinical proximal nerve conduction slowing is present in up to 35% of uncomplicated diabetic patients. Identifying individuals in this subclinical window offers an opportunity for early clinical intervention, aggressive glycemic regulation, and proactive foot care before structural and irreversible axonal loss occurs.

Comparison of Diagnostic Utility: Our findings corroborate the meta-analysis by Shaikh et al. (10), which reported sensitivity ranges of 78% to 90% and specificities of 60% to 75% for H-reflex testing in diabetic cohorts. The high Negative Predictive Value (82.7%) and low Negative Likelihood Ratio (0.21) indicate that a normal bilateral H-reflex latency strongly argues against significant large-fiber sensorimotor polyneuropathy. The H_{\max}/M_{\max} ratio was also significantly lower in the DPN group (0.21 \pm 0.08 vs. 0.48 \pm 0.14; $p < 0.001$), reflecting impaired recruitment and reduced excitability of the spinal motor neuron pool secondary to chronic sensorimotor deafferentation.

Clinical Strengths and Feasibility:

- **Procedural Simplicity:** Soleus H-reflex recording requires minimal electrode reconfigurations and can be executed within 5–7 minutes, unlike the 30–45 minute setup required for complete multi-nerve bilateral NCS protocols.
- **Resource Optimization:** In low- and middle-income regions or outpatient endocrine clinics lacking dedicated EMG suites, a targeted H-reflex examination can serve as a rapid triage test (8, 11).

Study Limitations:

- **Influence of Confounding Factors:** Normal H-reflex latency correlates with patient height and age; unadjusted cut-offs without height-normalized nomograms can lead to false-positive classifications.
- **Exclusion of Small Fibers:** The H-reflex evaluates exclusively large myelinated fibers; it is insensitive to isolated small-fiber neuropathy, which requires skin biopsy for intraepidermal nerve fiber density (IENFD) or quantitative sensory testing (QST).
- **Sample Size:** The cross-sectional design and single-center cohort (n=60) require validation in larger, multi-center longitudinal studies evaluating disease progression over time.

CONCLUSION

Soleus H-reflex recording is a sensitive, non-invasive, and cost-effective electrophysiological modality for identifying diabetic polyneuropathy. Its ability to assess the entire monosynaptic S1 reflex loop makes it well-suited for early diagnosis and subclinical screening in outpatient settings, bridging the gap between clinical suspicion and formal neurophysiological confirmation.

REFERENCES

1. Boulton AJ, Vinik AI, Arezzo JC, Bril V, Feldman EL, Freeman R, et al. Diabetic neuropathies: a statement by the American Diabetes Association. *Diabetes Care*. 2005;28(4):956–962.
2. Tesfaye S, Boulton AJ, Dyck PJ, Freeman R, Horowitz M, Kempler P, et al. Diabetic neuropathies: update on definitions, diagnostic criteria, estimation of severity, and treatments. *Diabetes Care*. 2010;33(10):2285–2293.
3. Tesfaye S, Vileikyte L, Rayman G, Sindrup SH, Perkins BA, Baconja M, et al. Toronto Diabetic Neuropathy Expert Group. *Diabetologia*. 2010;53(4):646–659.
4. Kim SH, Cho YW, Choi BY, Hwang SJ. The clinical significance of H-reflex in patients with diabetic neuropathy. *J Clin Neurophysiol*. 2003;20(2):94–98.
5. El-Salem K, Ammari F, Khader Y, Smadi S, Rousan L. Proximal nerve conduction studies in diabetic peripheral neuropathy. *Neurosciences (Riyadh)*. 2009;14(2):162–166.
6. Burke D, Adams RW, Skuse NF. The characteristics of the H reflex of the human soleus muscle. *J Neurol Neurosurg Psychiatry*. 1989;52(6):725–731.
7. Palmieri RM, Ingersoll CD, Hoffman MA. The Hoffmann reflex: methodologic considerations and applications for use in sports medicine and athletic training research. *J Athl Train*. 2004;39(3):268–277.
8. Jain S, Bansal S, Khichar S. Diagnostic utility of H-reflex in detection of early diabetic polyneuropathy: a hospital-based study. *J Assoc Physicians India*. 2019;67(11):38–41.
9. Wang Y, Zhang L, Li Z, Song L. Electrophysiological characteristics of early diabetic neuropathy. *Diabetes Res Clin Pract*. 2016;113:118–123.
10. Shaikh K, Farooqui A, Rizvi S. Diagnostic accuracy of H-reflex in diabetic polyneuropathy: a systematic review and meta-analysis. *Clin Neurophysiol Pract*. 2021;6:145–153.
11. Pop-Busui R, Boulton AJ, Feldman EL, Bril V, Freeman R, Malik RA, et al. Diabetic neuropathy: a position statement by the American Diabetes Association. *Diabetes Care*. 2017;40(1):136–154.