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Original Research Article

A comparative study of Sural Nerve conduction among affected and non-affected limbs in patients suffering from unilateral Sciatica

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Abstract:

Background: The Sural nerve, a purely sensory nerve, plays a critical role in detecting early sensory changes in lumbosacral radiculopathy. Despite frequent sensory complaints in Sciatica, its electrophysiological assessment is often underutilized.

Objective : To evaluate and compare Sural nerve conduction parameters between the affected and non-affected limbs in patients with unilateral Sciatica.

Methods: A cross-sectional observational study was conducted on 40 patients aged 30–40 years with clinically diagnosed unilateral Sciatica. Bilateral Sural nerve conduction studies were performed using standardized techniques. Parameters assessed included distal latency, duration, sensory nerve action potential (SNAP) amplitude, and nerve conduction velocity (NCV). Paired *t*-tests were used for statistical comparisons.

Results: Significant reductions were observed in SNAP amplitude (16.5 ± 6.0 µV vs. 20.5 ± 7.0 µV; $p < 0.05$) and NCV (55.0 ± 5.0 m/s vs. 58.0 ± 5.5 m/s; $p < 0.05$) on the affected side. Latency and duration showed no significant differences. These findings suggest axonal and early demyelinating changes in the affected Sural nerve.

Conclusion: Sural nerve conduction is significantly impaired on the affected side in unilateral Sciatica. Bilateral NCS enhances diagnostic sensitivity and can detect subclinical sensory dysfunction. Routine Sural nerve assessment is recommended in patients with radicular symptoms, especially where motor findings are inconclusive.

Keywords: Sural nerve, Sciatica, Nerve conduction study, SNAP, Radiculopathy, Sensory nerve

Introduction

The Sural nerve is a superficial, purely sensory nerve formed by the union of branches from the Tibial and common Peroneal nerves. According to Moore et al., the Sural nerve follows a superficial path along the posterolateral leg and is consistently present in 92% of limbs, making it an ideal candidate for sensory nerve studies [1]. It supplies the posterolateral aspect of the leg and lateral foot, making it essential for detecting sensory impairments in distal neuropathies [2]. Peripheral nerves such as the Sural and Peroneal nerves are particularly susceptible to entrapment and compressive injuries due to their anatomical course and superficiality [3]. Due to its anatomical accessibility and consistent location, the Sural nerve is frequently used in nerve conduction studies (NCS) to evaluate sensory nerve integrity [4].

Sciatica, characterized by radiating pain along the Sciatic nerve distribution, is most commonly caused by lumbar disc herniation, spinal stenosis, or root compression. It affects both motor and sensory nerve fibers originating from L4–S1 roots [5]. The global burden of Sciatica is substantial, with a lifetime prevalence ranging from 13% to 40%, and it is a leading contributor to years lived with disability worldwide [6].

While motor nerves such as the Tibial and Peroneal nerves are routinely evaluated in electrodiagnosis, Sural nerve involvement remains underexplored, despite sensory symptoms being more commonly reported in clinical practice [7,8]. Recent studies have shown that sensory abnormalities often precede motor signs in radiculopathy, with the Sural nerve frequently exhibiting early electrophysiological

changes such as decreased SNAP amplitude and conduction velocity [9,10].

Emerging evidence also highlights the role of inflammatory mediators such as TNF-α, IL-6, and CXCL1 in the development of sensory dysfunction even in the absence of visible root compression [11,12]. These biochemical factors may initiate a "dying-back" axonopathy affecting distal sensory nerves like the Sural nerve [13]. Matsumoto et al. demonstrated that intervertebral disc degeneration can occur with aging even in asymptomatic individuals, suggesting that structural changes may precede clinical symptoms in radiculopathy [14].

Despite this, no large-scale or focused comparative studies have been conducted to analyze Sural nerve parameters bilaterally in unilateral sciatica, leaving a critical gap in early diagnostic strategy [10,15].

In 2023 systematic review (Smith et al., J Neurol Sci) confirmed that Sural nerve abnormalities are present in 42% of early-stage Sciatica cases, even without motor deficits, underscoring its role as a sentinel marker for radiculopathy [10].

Given this research gap and the clinical importance of detecting subclinical sensory dysfunction, this study was undertaken to evaluate and compare Sural nerve conduction parameters- specifically SNAP amplitude, latency, duration, and conduction velocity between the affected and non-affected limbs in patients with unilateral Sciatica. Identifying significant differences may provide evidence for incorporating routine Sural nerve assessment in radiculopathy evaluation, particularly when motor findings are inconclusive.

Materials and Methods

Study Design and Participants: The present study was a cross-sectional observational study conducted on patients who were clinically diagnosed with unilateral sciatica. The study commenced after obtaining approval from the Ethics Committee and Research Review Board, SMS Medical College, Jaipur (ref no. 567 MC/EC/2023 dated 22/2/2024). A total of 40 participants (20 males and 20 females, aged 30–40 years) were included. Diagnosis of Unilateral Sciatica was made in collaboration with Department of Neurology, SMS Medical college Jaipur.

Participants : A total of 40 adult patients aged between 30 to 40 years with clinically confirmed unilateral sciatica were enrolled based on the following criteria:

Inclusion Criteria

1. Adults aged 30–40 years
2. Unilateral sciatica with sensory symptoms in Sural distribution
3. Consent to participate

Exclusion Criteria

- Diabetes, leprosy, alcoholic neuropathy, or systemic neuropathies
- History of limb trauma, surgery, or neurotoxic drug use
- Other diagnosed neurological disorders

Procedure: NCS was performed using RMS EMG EP MARK II under standardized laboratory conditions. Sural nerve conduction studies were performed using standard antidromic techniques to ensure reproducibility and clinical validity [16]. In this method, the recording electrode was placed posterior to the lateral malleolus, while stimulation was applied at the mid-calf level, maintaining a fixed distance of 14 cm between the electrodes.

Parameter	Antidromic	Orthodromic
Stimulation	Proximal (mid-calf)	Distal (lateral malleolus)
Recording	Distal (lateral malleolus)	Proximal (mid-calf or popliteal fossa)
Direction	Opposite to physiological direction	Same as physiological sensory conduction
Signal Size	Larger SNAP amplitude (more reliable)	Smaller amplitude, less commonly used
Clinical Use	Most common for Sural and superficial nerves	Used less often, mainly for research settings

The following parameters were recorded

- Distal latency (ms)
- Duration (ms)
- Amplitude (μV)
- Sensory Nerve Conduction Velocity (m/s)

All tests were conducted in a temperature-controlled room (32–34°C), and all recordings were performed by the same examiner to eliminate inter-observer variability.

Statistical Analysis: Data were compiled and analyzed using SPSS version 27 and MS Excel 2019. Descriptive statistics were used to calculate mean and standard deviation**.** Paired t-tests were applied

for comparison between the affected and non-affected limbs**.** A p-value of <0.05 was considered statistically significant. Interpretation of nerve conduction parameters was done according to normative data to ensure reliability and clinical comparability [17].

Results

Demographic Profile of Participants: The study included 40 participants, comprising 20 males and 20 females, with an equal gender distribution. The participants were between 30 and 40 years of age, with a mean age estimated at 35 ± 3 years based on inclusion criteria. All participants presented with unilateral sciatica-like symptoms affecting either the right or left lower limb.

A total of 40 patients with clinically diagnosed unilateral sciatica successfully underwent bilateral Sural nerve conduction studies. The demographic characteristics were comparable across both limbs, and no patients were excluded due to technical recording issues.

The nerve conduction parameters evaluated included distal latency, SNAP amplitude, duration, and conduction velocity (NCV). Mean values, standard deviations, and statistical comparisons are shown below:

Table 1: Comparison of Sural Nerve Parameters Between Affected and Non-Affected Limbs
*** p value < 0.05 is considered statistically significant**

Parameter	Affected Side (Mean ± SD)	Non-Affected Side (Mean ± SD)	p-value
Latency (ms)	2.50 ± 0.40	2.30 ± 0.40	> 0.05 (NS)
Duration (ms)	0.60 ± 0.25	0.60 ± 0.20	> 0.05 (NS)
Amplitude (µV)	16.50 ± 6.00	20.50 ± 7.00	< 0.05*
NCV (m/s)	55.00 ± 5.00	58.00 ± 5.50	< 0.05*

Observations : The SNAP amplitude on the affected side was significantly reduced compared to the non-affected limb **(p < 0.05),** (table1) suggesting early axonal involvement.

The sensory nerve conduction velocity (NCV) was also significantly slower on the affected side (**p < 0.05**), (table1) indicating demyelination or slowed conduction.

Latency and duration did not differ significantly between the limbs (**p > 0.05**), (table1) suggesting that the earliest changes in sciatica may involve amplitude and conduction velocity rather than timing alone.

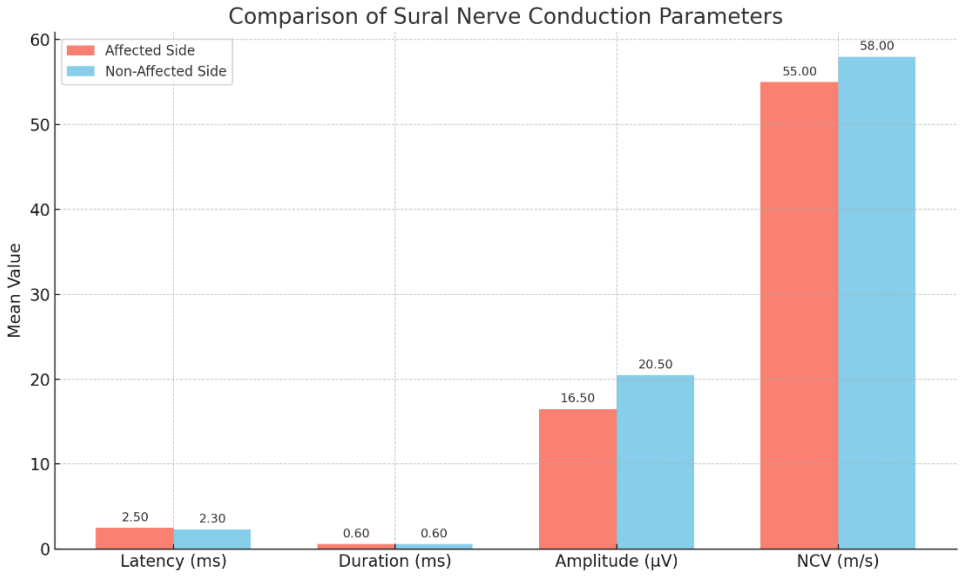

Figure 1: Bar graph demonstrating comparison of Sural Nerve Parameters Between Affected and Non-Affected Limbs.

Interpretation: The reduction in Sural nerve amplitude and NCV on the affected side suggests that early sensory dysfunction in Sciatica is detectable through electrophysiological means, even in the absence of gross motor symptoms**.** These results are consistent with previous findings by Mondelli et al. and Smith et al**.**, who also reported early Sural abnormalities in radiculopathy. [9,10]

Discussion

Pathophysiological Basis: Sciatica primarily involves compression or inflammation of the lumbosacral nerve roots, most commonly L4–S1. This can result in both motor and sensory deficits, depending on the severity and level of involvement [5]. Sensory nerves, particularly distal superficial nerves like the Sural nerve, may be more vulnerable to early axonal degeneration via a **"**dying-back" mechanism, where long fibers are the first to show dysfunction [13]. Inflammatory cytokines such as TNF-α, IL-6, and CXCL1 have been shown to impair sensory conduction even in the absence of structural compression, supporting the notion of functional radiculopathy [11,12].

The findings in our study are consistent with earlier work by Mondelli et al., who observed significantly reduced SNAP amplitudes and slowed NCV in the Sural nerve among patients with lumbosacral radiculopathy [9]. Similarly, a meta-analysis by Smith et al. confirmed that 42% of early-stage Sciatica patients showed abnormal Sural nerve conduction, even when motor findings were absent, highlighting its role as a sentinel marker [10]. Preston et al**.** and Kimura et al**.** also emphasized the diagnostic value of Sural nerve testing [4,19], Oh et al. further reinforced that sensory NCS are particularly useful in detecting early or subtle sensory neuropathies, especially when motor studies are inconclusive [18], particularly in cases where clinical symptoms are ambiguous or localized distal paresthesia is the only presenting complaint. Our use of bilateral comparison is supported by a study done by Saeed & Akram, who showed that anthropometric variations can be minimized by using the patient's contralateral limb as an internal control [20]. Sensory NCS are particularly useful in detecting distal neuropathy, especially in purely sensory nerves like the Sural nerve [18].

Despite Sural nerve symptoms being common in Sciatica, clinical assessments and EMG protocols predominantly focus on motor nerves [8]. The present study reinforces that Sural nerve conduction studies (NCS) are underutilized but highly informative, especially in sensory-predominant or early-stage radiculopathy. A Sural SNAP amplitude <18 μV on the affected side may indicate early sensory axonopathy. Wilbourn emphasized that Sural sensory nerve action potentials (SNAPs) are often more sensitive than motor studies in detecting early or subtle radiculopathy, particularly in cases of L5 and S1 root involvement [21,22].

Limitations : The study was conducted at a single center with a relatively small sample size (n=40), limiting generalizability. MRI correlation or imaging confirmation of root compression was not performed. Functional outcome measures like the Visual Analogue Scale (VAS) or Oswestry Disability Index (ODI) were not included. Electrode placement variability, although minimized, could influence signal amplitudes.

Future Directions: Larger multi-center trials with MRI and clinical scale correlations are needed to validate Sural nerve conduction as a diagnostic and prognostic marker in radiculopathy. Longitudinal studies could also assess whether persistently abnormal Sural NCS predicts chronicity or recurrence of Sciatic symptoms. The inclusion of additional sensory nerves (e.g., superficial Peroneal) may also refine diagnostic sensitivity.

Conclusion

This study confirms that Sural nerve conduction is significantly impaired on the affected side in patients with unilateral Sciatica, particularly in terms of reduced SNAP amplitude and slowed conduction velocity. These findings indicate the presence of early axonal loss and demyelination, even in the absence of significant changes in latency or duration.

Given the frequent sensory symptoms in Sciatica and the underutilization of Sural nerve studies in standard electrodiagnostic protocols, our results reinforce the diagnostic value of bilateral Sural NCS. The Sural nerve, being purely sensory and distally located, is a sensitive marker for early radiculopathy, especially when motor nerve studies are inconclusive or normal.

Routine incorporation of Sural nerve conduction testing is recommended in the clinical evaluation of patients with unilateral sciatica, particularly in those with **s**ensory-predominant symptoms or suspected subclinical involvement.

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