# Characterization of the sensory nerve action potential of the Sural Nerve in patients over 60 years of age without peripheral neuropathy

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We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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Abstract

Background**:** Demonstration of the possibility to obtain the sensory nerve action potential (SNAP) of sural nerve in patients over 60 years old, without peripheral neuropathy.

Methods: Prospective study on 101 patients between ages 60 and 90. Stimulation was applied 12 cm proximal to the recording point.

Results: 202 SNAPs of the sural nerve were collected with an average peak latency of 3.2 ms, base latency of 2.6 ms, peak-to-peak amplitude of 15.2 μV and velocity of 45.7 m/s

Conclusions: It was possible to obtain the sural nerve SNAP in all tested patients older than 60, without peripheral peripheral neuropathy. The values obtained in the study prove to be useful as reference in the evaluation of patients older than 60 years of age.

Keywords: electrodiagnosis, conduction, values, sural, elderly.

## 1 | INTRODUCTION

Electrodiagnostic studies (EDX) play a key role in the evaluation of patients with disorders in the peripheral nervous system and sensitive nervous conduction, such as the one of the sural nerve. These evaluations are a fundamental part in the protocol of electrophysiological evaluation in these patients. [1]

The sural nerve is a sensitive nerve[2] that innervates the posterolateral side of the leg and the dorsolateral aspect of the foot. It is made up of a medial branch originating in the tibial nerve and a lateral one that comes from the common fibular nerve.

The sural nerve is vulnerable to polyneuropathies, traumatic injuries, surgeries in the area of the nerve, neoplastic compressions[2] and, occasionally, it is altered in lumbosacral radiculopathies. The main goal of this study was to demonstrate the possibility of obtaining sensory nerve action potential (SNAP) of the sural nerve in patients older than 60 years of age, without peripheral neuropathy. Another goal was to establish reference values for SNAP of the sural nerve for this age group since, currently, there are no reference values for patients over 60 years of age that meet all requirements of the Normative Data Task Force (NDTF) of the American Association of Neuromuscular & Electrodiagnostic Medicine (AANEM) [3].

## 2 | METHODS

This study was conducted in the Electrodiagnostic Department of the Health Services Provider Institution of the University of Antioquia, León XIII, Medellín-Colombia. The study was conducted from December 2013 to September 2020 at the Electrodiagnostics Department at the IPS Universitaria León XIII, the institution that offers health services at University of Antioquia, in

Medellín-Colombia. 101 patients that met the inclusion criteria, and agreed to participate in the study, were enrolled in the cohort. All these patients gave their signed informed consent.

From December 2019 to September 2020, a total of 234 ambulatory patients attended the electrodiagnostics laboratory to participate in studies of nerve connections of the lower extremities or all four extremities, as referred by their treating physician. 133 patients were excluded: 14 patients did not agree to participate in the study; 33 patients had a medical history or physical exam that was compatible with peripheral neuropathy as defined by an altered monofilament test[4] and any of the following: decreased muscle strength according to the Medical Research Council scale and not presenting a myotomal distribution, decreased or absent osteotendinous reflexes, surface impaired sensation; and, 86 patients because of a medical history of diabetes mellitus, presence of scars, edema, infections or active ulcers in the area where the sural SNAP would be recorded. The completion of the SNAP was carried out by a University of Antioquia certified Physical Medicine and Rehabilitation specialist.

The project was approved by the Research Ethics Committee of the School of Medicine, University of Antioquia and the Ethics Committee of the Department of the Health Services Provider Institution of the University of Antioquia, León XIII[5]

## 2.1 | Description of the technique

Electrodiagnostic equipment Cadwell Sierra Wedge II, (Cadwell Laboratories, Inc.909 Kellogg, Street- Kennewick, Washington 99336) was used to record the antidromic sensory nerve action

potential (SNAP) in a bilateral way. A bar recording electrode (Cadwell 302247-200) with an interelectrode separation of 3 cm, which was placed behind the lateral malleolus, with stimulation applied 12 cm proximal to the recording point. A flat disc electrode, E0 (Cadwell 302150-200), was placed between the stimulation and recording sites. (6) (Figure 1 EO). Percutaneous stimulation was applied by using a bipolar stimulator with a distally placed cathode. The onset latency, peak latency, peak-to-peak amplitude, and conduction velocity parameters were recorded. Skin temperature of the leg was monitored using an infrared surface thermometer, to ensure that it was >33°C. The electrodiagnostic equipment was standardized with a low frequency filter of 20 Hz, a high frequency filter of 2000 Hz, gain of 15 μV and sweep of 1.5 ms per division. On average, a stimulus intensity of 20 mA was needed to achieve supramaximal activation.


Figure 1. Recording sites and stimulation of the sural SNAP.

Note: Abbreviations: S stimulation point, EO ground electrode, E1 active electrode, E2 reference electrode.

## 2.2 | Analysis

Normality of data was tested using the Kolgomorov-Smirnoff test, creating frequency histograms that helped in determining the normality of data and information on measurements of central tendency. A non-normal distribution was found, median and interquartile ranges were reported, and other descriptive statistics such as minimum, maximum, 3rd percentile and 97th percentile values and 95% confidence intervals for the mean were reported.

The required NDTF and AANEM[2] guidelines were used for sample selection, selection criteria and data analysis. The statistical program SPSS version 25, licensed by the University of Antioquia, was used.

## 3 | RESULTS

101 patients were evaluated, 62.4% females and 37.6 males. The average age was 72.5 years old. 202 SNAPs of the sural nerve were recorded with an average peak latency of 3.2 ms, base latency of 2.6 ms, peak-to-peak amplitude of 15.2 μV and velocity of 45.7 m/s.

According to the Kolmogorov-Smirnov Test for Normality, the variables corresponding to latency, amplitude and velocity of conduction demonstrate a non normal distribution. Therefore, a logarithmic conversion of these was performed, without achieving a statistically significant difference among the evaluated age ranges.

**Table 1.** Table of variables in relation to the SNAP of sural nerve in patients older than 60 years of age, without peripheral neuropathy.

| | Mean | Median | Minimum | Maximum | P3 | P97 | Total |
|---|---|---|---|---|---|---|---|
| **Age** | 72.5 | 73.0 | 60.0 | 97.0 | 60.0 | 88.9 | 101 |
| **Average amplitude (μV) RLE – LLE** | 15.2 | 13.5 | 4.8 | 35.7 | 6.4 | 26.9 | 202 |
| **Amplitude MID (μV)** | 15.3 | 13.6 | 5.0 | 59.3 | 5.6 | 34.6 | 101 |
| **Amplitude MII (μV)** | 15.1 | 13.3 | 5.6 | 42.9 | 6.3 | 36.3 | 101 |
| **Average peak latency (ms) RLE – LLE** | 3.2 | 3.2 | 2.5 | 4.5 | 2.6 | 3.9 | 202 |
| **Peak latency (ms) RLE** | 3.2 | 3.2 | 2.5 | 3.9 | 2.6 | 3.9 | 101 |
| **Peak latency (ms) LLE** | 3.2 | 3.2 | 2.5 | 4.4 | 2.5 | 3.8 | 101 |
| **Average onset latency (ms) RLE – LLE** | 2.6 | 2.7 | 1.9 | 3.2 | 2.1 | 3.1 | 202 |
| **Onset latency (ms) RLE** | 2.6 | 2.6 | 1.9 | 3.2 | 2.0 | 3.1 | 101 |
| **Onset latency (ms) LLE** | 2.7 | 2.7 | 1.9 | 3.9 | 2.1 | 3.0 | 101 |
| **Average velocity(m/s) RLE – LLE** | 45.7 | 44.7 | 37.7 | 62.7 | 38.9 | 55.7 | 202 |
| **Velocity (m/s) RLE** | 46.2 | 45.3 | 37.1 | 61.5 | 37.7 | 58.8 | 101 |
| **Velocity (m/s) LLE** | 45.3 | 44.9 | 37.7 | 63.8 | 39.7 | 56.2 | 101 |

LLE: Left Lower Extremity, RLE: Right Lower Extremity, μV: microvolts, ms: milliseconds, m: meters, m/s: meters per second, P3: percentile 3, P97: percentile 97

An ANOVA Test was used to calculate the difference among each of the three specified age groups (60 to 70 years, 71 to 80 years and over 81 years old) in order to assess the effect of age on SNAP sural nerve. No significant statistical differences were found among the groups. (Table 2).

**Table 2.** Table of variables in relation to SNAP by age groups.

| | Velocity (m/s) 60-70 years old n=44 | Amplitude (µV) 60-70 years old n=44 | Latency base/peak (ms) 60 – 70 years old n=44 | Velocity (m/s) 71-80 years old n=40 | Amplitude (µV) 71 – 80 years old n=40 | Latency base/peak (ms) 71-80 years olds n=40 | Velocity m/s >80 years old n=40 | Amplitude (µV) > 81 years old n=17 | Latency base/peak (ms) > 81 years old n=17 |
|---|---|---|---|---|---|---|---|---|---|
| **Mean** | 45.17 | 16.2 | 2.6/3.1 | 46.93 | 14.7 | 2.6/3.2 | 44.36 | 13.6 | 2.7/3.4 |
| **Median** | 44.61 | 13.9 | 2.7/3.1 | 46.50 | 13.0 | 2.6/3.2 | 43.41 | 12.4 | 2.8/3.3 |
| **P3** | 39.13 | 7.3 | 2.2/2.5 | 39.12 | 5.1 | 2.0/2.6 | 51.28 | 6.9 | 2.3/2.9 |
| **P97** | 56.22 | 33.8 | 3.1/4.3 | 61.30 | 34.2 | 3.0/3.9 | 50.91 | 22.6 | 3.1/3.8 |

µV: microvolts, ms: milliseconds, P3: percentile 3, P97: percentile 97

## 4 | DISCUSSION

Sensitive nerve conduction is an essential part in electrophysiology studies; among these, the sural nerve one is mandatory in some diagnostic protocols such is the case of polyneuropathies. (7, 8, 9, 12). The ability to diagnose neuropathy in people over 60 years of age, through nerve conduction studies, depends on the reference ranges established for the population group. This often presents a challenge because of possible contradictory reference values of these conductions. It is advisable to point out that the lack of reference values for this age group could lead to erroneous conclusions regarding the presence or absence of a peripheral neuropathy and unjustly increase the cost of care for health systems. Some authors have reported an increase in the incidence of the absence of sural SNAP with the increase in age, even by up to 40% of those over years of age (10, 11). Most of the time, its absence is attributed to age-related conditions and some differential diagnosis of importance for these patients can be overlooked. The parameters most affected by the physiological changes of age are the nerve conduction velocity which decreases slightly with age (this effect is greater in the sensitive fibers than in the motor ones) and the amplitude, which can fall up to 50%. Therefore, SNAP responses in elderly patients should always be interpreted with caution and not necessarily considered abnormal without evaluating other confirmation data (13.14).

In all patients evaluated in our study, it was possible to obtain a reproducible response of sural SNAP with a peak-to-peak amplitude value > 4μV (15). This finding coincides with those of Esper et al, Tavee et al, and Hoyos-Arango B (13, 11, 16) who obtained SNAP of the Sural nerves in healthy subjects older than 60 years and found a reduction in the amplitude of the sural SNAP as age progressed (11). It should be noted that our data show that it is possible to find the Sural

SNAP even in people over 90 years, which is why the absence of sural SNAP in patients over 60 years should be interpreted as an abnormal finding and not as a physiological result of aging, in order to be able to carry out the necessary complementary studies to arrive at a more precise diagnosis and to have access to possible treatment options.

Our values could be used as a reference for the diagnosis of neuropathy of large fibers or as part of the protocol of electrophysiological evaluation in patients over 60 years with suspicion of radiculopathy or plexopathy. Taking into account the sural SNAP is one of the most widely used techniques in everyday life in an electrodiagnostic laboratory, it would have been interesting to have established the reference values with regard to size and body mass index. The results of this study have, as clinical importance, to know that it is possible to obtain sural nerve SNAP in all patients over 60 years of age evaluated, without peripheral peripheral neuropathy, and the reference values of sural nerve SNAP in this age group.

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## Abbreviations

AANEM: The American Association of Neuromuscular & Electrodiagnostic Medicine.

EDX: Electrodiagnostic

LLE: Left Lower Extremity

m/s: meters per second

ms: milisegundos

ms: milliseconds

NDTF: The Normative Data Task Force.

RLE: Right Lower Extremity

SNAP: sensory nerve action potential

μV: microvolts.

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