



Sural and Radial Sensory Responses in Patients with Sensory Polyneuropathy

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Abstract

Introduction: The sural/radial nerve amplitude ratio (SRAR) is the quotient of the Sensory Nerve Action Potential (SNAP) amplitudes (Amp) of the sural and the superficial radial nerve. It has been hypothesized that this ratio can be used for the detection of early axonal loss; because the sural SNAP amplitude will decrease first, thereby also decreasing the SRAR value.

Objectives: To determine the sensitivity and specificity of SRAR, age-adjusted sural and radial SNAP Amp in the diagnosis of axonal sensory polyneuropathy in cancer patients.

Design: Retrospective review.

Setting: Comprehensive cancer center.

Patients: One hundred and ninety one EMG reports from January 2001 to December 2005.

Methods: The independent variable is the diagnosis of axonal sensory polyneuropathy in the EMG reports that is based on multiple tests.

Main outcome measurements: We assessed the agreement between classifications of axonal sensory polyneuropathy made using the current 'gold standard' and the proposed method that is based on patients' age-adjusted radial and sural SNAP amplitude; an SRAR being above or below the normal value (0.21).

Results: We found that the sensitivities for age-adjusted radial SNAP Amp, age-adjusted sural SNAP Amp, and SRAR were 33%, 64%, 56% respectively; the specificities were 85%, 70%, 77% respectively.

Conclusions: SRAR is neither the most sensitive, nor the most specific in the diagnosis of axonal sensory polyneuropathy.

Keywords

Polyneuropathy, Radial nerve, Sural nerve, Sural/radial amplitude ratio (SRAR)

sural and radial SNAPs are especially useful in the electrodiagnosis of polyneuropathy.

Previous studies showed that the sural/radial nerve amplitude ratio (SRAR) is more resistant to physiological variables, such as BMI [1], age [2-7], sex, or method of calculation [8]. They proposed using a reduction in the Sural/Radial Amplitude Ratio (SRAR) as a marker for polyneuropathy, as this parameter appears more resistant to the effects of aging than sural SNAP amplitude alone [9]. Because studies have found that SRAR is more resistant to changes in BMI and age, an age-independent value for SRAR with the cut-off value of 0.21 was established to use in polyneuropathy studies [8,10].

In addition, a previous study examined a population of normal subjects who did not have clinical evidence of peripheral nerve dysfunction to determine the lower limits of the normal values (LLN) for sural and radial SNAP amplitudes for various age groups [10]. In our study, we utilized these previously established lower limits of the normal values (LLN) for sural and radial SNAP amplitudes and the age-independent value for SRAR to determine the sensitivity and specificity of these values. We also compared these result to a commonly-used sural SNAP amplitude cut-off value of 5 μ V in the diagnosis of distal axonal sensory polyneuropathy in cancer patients.

Materials and methods

A Comprehensive Cancer Center Institutional Review Board approved this study.

Population

Cancer patients who had underwent nerve conduction and electrodiagnostic study from January 2001 to December 2005. The inclusion criteria were as following: both sural and radial sensory nerve conduction studies were done, skin temperature $\geq 32.0^{\circ}\text{C}$ and the patient's age were over 18 years old. Nerve conduction studies without a recorded skin temperature or had skin temperature $< 32^{\circ}\text{C}$ were excluded from analysis.

Electrophysiological tests

All nerve conduction studies were performed with the Viking IV-D (Nicolet, Madison, Wisconsin) electromyography unit. The diagnosis of distal axonal sensory polyneuropathy was extracted from EMG reports based presence of bilateral, symmetric, distal

Introduction

The amplitude of Sensory Nerve Action Potentials (SNAPs), as an indicator for the amount of peripheral sensory nerve axon, is important in the diagnosis of peripheral neuropathy. Since the sural and radial nerves are at low risk for compressive injury, the

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Table 1: Number of Patients with and without Diagnosis of Peripheral Neuropathy (PN) and their Respective Categories for Sural and Radial Sensory Nerve Action Potential (SNAP) Amplitude and Sural/Radial Nerve Amplitude Ratio (SRAR).

	No Diagnosis of PN (n=99)	Diagnosis of PN (n=45)
Normal age-adjusted sural SNAP	69	16
Abnormal age-adjusted sural SNAP	30	29
Normal age-adjusted radial SNAP	85	30
Abnormal age-adjusted Radial SNAP	14	15
Normal SRAR (≥ 0.21)	77	20
Abnormal SRAR (< 0.21)	22	25
Sural Amp $\geq 5 \mu\text{V}$	82	21
Sural Amp $< 5 \mu\text{V}$	17	24

Table 2: Sensitivity and Specificity of Each Test in Diagnosis of Distal Axonal Sensory Polyneuropathy.

	Sensitivity (%)	Specificity (%)
Age-adjusted Sural SNAP	64	70
Age-adjusted Radial SNAP	33	85
SRAR	56	77
Sural SNAP < 5	53	83

lower extremity symptoms (numbness, tingling, dysesthesia, etc); absence of muscle weakness; absence of upper motor neuron signs; absence of radicular distribution of pain; abnormality sensation on neurological examinations and electrophysiological studies⁹. The reports were generated by AANEM certified electromyographers.

Sural Nerve Conduction Study (NCS)

Subjects were placed side-lying. The active electrode was placed between the lateral malleolus and the heel, and the reference electrode 3 cm more distally at the lateral edge of the foot. Supramaximal stimuli were applied 12-14 cm proximal to the active electrode, just lateral from the midline of the calf.

Superficial radial NCS

Subjects were seated or supine. The active electrode was placed over the superficial radial nerve where it overlies the tendon of the extensor pollicis longus muscle. The reference electrode was placed 4 cm distally between the first and second metacarpophalangeal joints. Stimuli were applied 10 cm proximal to the active electrode over the radius.

Data analysis

We used the previously established 5% lower limit of the normal value (LLN) as the cut-off [10] for age-adjusted sural SNAP amplitude (for ages < 39 ; 40-59; and > 60 , the amplitudes used were 14, 7, 3 μV respectively). We used the previously established 5% lower limit of the normal value (LLN) for age-adjusted radial SNAP amplitude (for ages < 39 ; 40-59; and > 60 , the amplitudes used were 26; 17; 12 μV respectively). The SRAR cut-off value used was 0.21 (95% CI 0.18-0.29) for the entire population. We also used the commonly used sural SNAP cut-off value 5 μV , to assess its sensitivity and specificity.

The SRAR was calculated by dividing the highest sural nerve amplitude by the highest superficial radial nerve amplitude ("highest/highest SRAR").

The sensitivity and specificity results were then found by calculating frequencies using these cut-off values and comparing them to those of the final diagnosis made by the staff physician.

Statistical analyses were performed using SAS version 9.1 (SAS Institute, Inc., Cary, North Carolina).

Results

From a total of 191 EMG studies reviewed, 24 studies were excluded because they did not meet the criteria for temperature, 15

studies were not included because of missing data on radial or sural NCS, and 2 studies were excluded because of age < 18 years.

In total, 150 subjects (71 men, 79 women) were included in the analysis. Their mean age was 55 years (range 19-84), mean BMI of 28.9 ± 8.7 . The tumor diagnoses of these patients were 37% (55/150) hematological malignancy, 62% (93/150) with solid tumor. Table 1 shows the number of patients with and without diagnosis of distal axonal sensory polyneuropathy and their respective categories for sural and radial SNAP Amplitude and SRAR. Table 2 shows the sensitivity and specificity of each test in comparison to the final diagnosis of peripheral neuropathy (Table 1, 2).

Discussion

Sensory nerve conduction studies of the sural and radial nerves are widely used in the electrodiagnosis of polyneuropathy. Sural SNAP amplitude is probably the most useful parameter for differentiating normal subjects from those with distal sensory polyneuropathy [10].

The findings of this study indicate that SRAR was only able to increase the diagnosis of sensory peripheral neuropathy specificity by 7% but decrease the sensitivity by 8%, compared to age-adjusted sural SNAP. Our results also indicate that the age-adjusted radial SNAP had the highest specificity of 85%. SRAR is less sensitive compared to sural SNAP, suggesting sural SNAP might be more useful in detecting early sensory peripheral neuropathy, such as chemo-induced peripheral neuropathy. From our clinical experience, there is a subgroup of patients with milder clinical presentations of sensory neuropathy and normal routine NCS, which pose a diagnostic dilemma for clinicians. It is in this group where age-adjusted sural SNAP can be useful for early diagnosis of distal sensory polyneuropathy. Our results also show that using age-adjusted sural amplitude as a cut-off is more sensitive to the diagnosis of peripheral polyneuropathy compared to using a commonly used cut-off of 5 μV .

In this study, we considered a SRAR < 0.21 as abnormal. We used this cut-off because two large separate normative data studies found a SRAR of approximately 0.21 to represent the fifth percentile of normal [8,11]. Prior studies describing the SRAR cutoff of 0.21 yielded a specificity of 96% in differentiate radiculopathy and sensory neuropathy, but in the present study in cancer patients, the specificity is only 77%, which is lower than the specificity provided by age-adjusted radial SNAP.

Our data was obtained by different clinicians; it truly reflects routine clinical practice and minimizes investigator bias that could lead to an overestimation of the value of the tests under investigation. On the other hand, since it was a retrospective study, the fact that not all conduction studies were carried out in each patient may have biased the results, which could limit the ability to accurately establish the optimal yield of the tests. Another factor to consider is that the majority of these patients had cancer and many of them likely had peripheral neuropathy secondary to cancer treatment. Studies comparing SRAR to sural and radial SNAP amplitudes in other patient populations are needed.

Conclusion

This study suggests that the age-adjusted sural SNAP is most sensitive in the diagnosis of early distal sensory polyneuropathy. Our results also indicate the SRAR is only of a marginal benefit in increasing specificity (7%) and therefore does not add additional value in the diagnosis of distal sensory polyneuropathy.

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