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Diagnostic utility of distal nerve conduction studies and sural near-nerve needle recording in polyneuropathy

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HIGHLIGHTS

- The sensitivity of dorsal sural and medial plantar nerve conduction studies (NCS) was 72% and 75% in 68 PNP patients.
- Dorsal sural nerve NCS showed high specificity (85%) and positive predictive value (94%) for PNP.
- Distal NCS, especially of the dorsal sural nerve, match near-nerve technique in diagnostic power.

ABSTRACT

Objective: The electrodiagnosis of polyneuropathy (PNP) may benefit from examination using near-nerve needle technique (NNT) and from inclusion of distal nerves. This study compared the diagnostic utility of distal nerve conduction studies (NCS) and NNT recording.
Methods: Bilateral NNT and surface recording of the sural nerve and surface recording of the dorsal sural and medial plantar nerves were prospectively done in 91 patients with clinically suspected PNP. Distal NCS were additionally done in 37 healthy controls. Diagnostic reference standard was the final clinical diagnosis retrieved from the patients medical records after 1–4 years.
Results: The clinical follow-up diagnosis confirmed PNP in 68 patients. Equally high sensitivities of the dorsal sural (72%), medial plantar (75%), and sural nerve with NNT recording (77%) were seen, while the sensitivity of conventional surface recording of the sural nerve was lower (60%). Sural NCS with both NNT and surface recording and dorsal sural NCS showed high specificities (85–95%) and positive predictive values (94–98%), while a lower specificity was seen for the medial plantar nerve (68%).
Conclusion: NCS of distal nerves, especially the dorsal sural nerve, have high diagnostic power equalling sural NNT recording.
Significance: The electrodiagnostic evaluation of patients with suspected PNP benefits from NCS of distal nerves.

1. Introduction

Nerve conduction studies (NCS) are a very useful tool in diagnosing polyneuropathy (PNP) both with respect to confirming the PNP and classifying it as primarily demyelinating or axonal (Donofrio and Albers, 1990; Tankisi et al., 2005). Since most PNPs follow a length dependent pattern, the sensory nerves of the feet are usually affected in the early stages (Oh et al., 2001; Park et al., 2003; Singleton et al., 2008; Singleton, 2005). The sural nerve is the most frequently examined nerve in the electrodiagnosis of PNP (Burke et al., 1974). However, the segments distal to the ankle are not assessed by conventional NCS of the sural nerve, and a distal sensory PNP affecting the feet may therefore be missed (Killian and Foreman, 2001). Previous studies have shown that the examination of distal nerves, i.e. dorsal sural nerve (Turgut et al., 2004; Turgut et al., 2006b) and medial plantar nerve (Altun et al., 2011; Loseth et al., 2007; Sylantiev et al., 2008) provide earlier diagnosis of PNP.

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The sural nerve can be examined either by surface electrode recording (Falck et al., 1994), which is the most commonly used method, or by near-nerve technique (NNT) (Behse and Buchthal, 1971; Buchthal and Rosenfalck, 1971; Trojaborg, 1992). We have previously shown that examination of the sural nerve is more sensitive with NNT compared to surface recording in diabetic patients (Kural et al., 2016). However, the examination with NNT is often unpleasant for the patient due to needle insertions and is also more time consuming than surface electrode recording.

The present study aimed of comparing the sensitivity and specificity of distal surface electrode recording of the dorsal sural and medial plantar nerves with NNT and conventional surface recording of the sural nerve in a larger cohort of patients referred for electrodiagnostic evaluation on clinical suspicion of PNP. The final clinical diagnosis obtained from review of the patients' electronic medical records was used as diagnostic reference standard (Bossuyt et al., 2015).

2. Material and methods

2.1. Patients

Ninety-one consecutive adult patients referred by the Department of Neurology, Aarhus University Hospital for electrodiagnostic evaluation of suspected PNP were prospectively included in the study.

The patients' medical records were reviewed 1–4 years after the neurophysiologic investigation for etiological causes and a final clinical diagnosis given by the neurologists on available criteria for specific types of PNP, such as Guillain–Barré syndrome and chronic inflammatory demyelinating polyneuropathy. The Ethics Committee of the Central Denmark Region and the Danish Data Protection Agency approved the study.

2.2. Neurologic examination

Before the neurophysiologic investigation, all patients underwent a detailed neurologic examination including scoring on the Utah Early Neuropathy Scale (UENS) for quantification of the clinical involvement. The UENS is a validated test focusing on sensory involvement in PNP with a maximum score of 42 points (Singleton et al., 2008).

2.3. Electrodiagnostic studies

All NCS were done using Keypoint.Net EMG equipment (Dantec, Skovlunde, Denmark). In all patients, the sural, dorsal sural, and medial plantar nerves were examined bilaterally using surface electrodes, and the sural nerve was additionally examined using NNT. All studies were done according to the department's protocol for surface electrode recordings and NNT. For surface recordings, disposable pregelled surface electrodes (Ag/AgCL) with a recording area of 15 mm × 20 mm were used (9013S0212 Dantec/Natus). The skin temperature was maintained at 32–36 °C by a heating lamp. All sensory recordings were done with averaging of at least 20 stimuli, and up to 500 stimuli for identification of small SNAPs. In addition, bilateral peroneal and tibial motor NCS, and unilateral median and/or ulnar motor and sensory NCS were performed as part of the diagnostic workup (data not presented).

The examinations were performed by the same experienced neurophysiologist (HT) and were done in the same order for every patient, starting with the conventional sural nerve with surface electrodes, followed by dorsal sural and medial plantar nerves and lastly the sural nerves using NNT.

2.3.1. Sural nerve antidromic surface recording

The surface sural sensory nerve action potential (SNAP) was obtained by recording behind the lateral malleolus and stimulating 13 cm proximally, lateral to the edge of the Achilles tendon (Falck et al., 1994). The nerve was stimulated antidromically using a surface bar stimulator (Dantec 13L36) with a distance of 23 mm between the cathode and anode. As described elsewhere, the amplitude was measured peak-to-peak and the latency was calculated from the stimulus onset to the first positive peak for determination of conduction velocity (CV) (Falck et al., 1994).

2.3.2. Sural nerve orthodromic near-nerve needle recording

Insulated needles (0.7-mm diameter) with a 3-mm bared tip were inserted close to the sural nerve at the lateral malleolus for supramaximal stimulation, and at mid calf 12–13 cm proximal to the lateral malleolus for orthodromic SNAP recording (Tankisi et al., 2014). The reference electrode had a 5-mm bared tip and was inserted 2.5–3.5 cm crosswise at mid-calf and lengthwise at the lateral malleolus. A threshold of <1 mA was used for both antidromic and orthodromic stimulation for placement of the needle electrodes close to the nerve (Tankisi et al., 2014). Between 50 and 400 stimulations were typically used to record small SNAPs. CV was obtained by measuring the latency to the initial positive peak of the action potential and amplitudes were measured peak to peak.

2.3.3. Dorsal sural and medial plantar NCS

Dorsal sural and medial plantar nerves were stimulated antidromically using a surface bar stimulator (Dantec 13L36). To obtain the dorsal sural SNAP, the surface recording electrode was placed at the mid-portion of the fifth metatarsal bone just lateral to the extensor digitorum longus tendon of the fifth toe with the reference electrode 2 cm distally. The stimulation site was posterior to the lateral malleolus with the cathode placed 12 cm proximal from the recording electrode. A ground electrode was placed between the recording and the stimulating electrodes.

The medial plantar mixed nerve was stimulated orthodromic at the medial sole over a line connecting the midpoint of the heel and the first toe using a surface bar stimulator (Dantec 13L36). The surface recording electrode was placed over the tibial nerve above and posterior to the medial malleolus at a distance of 14–16 cm. A ground electrode was placed between the recording and the stimulating electrodes. The nerve was stimulated supramaximally without producing a toe-flexor twitch in order to avoid interference by a volume-conducted motor response (Nodera et al., 2002).

Latencies for dorsal sural and medial plantar nerves were calculated from the stimulus onset to the first positive peak for determination of CV and amplitudes were measured peak-to-peak.

2.4. Data analysis

Data from the healthy controls were used as normative limits for all surface recordings (sural, dorsal sural, and medial plantar nerves). Values within ±1.96 standard deviation (SD) from mean of controls were regarded normal. For NNT examination of the sural nerve, the laboratory control material was used. Values exceeding ±2 SD were considered abnormal.

The patients were divided into two groups with either PNP confirmed (PNP+) or excluded (PNP−) according to the clinical follow-up. The incidence of abnormal nerves were compared between the two patient groups and the healthy controls.

For calculation of sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV), NCS abnormalities, i.e. decrease in CV or in SNAP amplitude, were seen in relation to the clinical follow-up diagnosis.