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Prolongation of the tibialis anterior CMAP duration in chronic inflammatory demyelinating polyneuropathy

Hiroyuki Nodera [a,b,*], Norman Latov [a], Bridget Carey [a], Jennifer Langsdorf [a], Veronica Bedoya [a], Svetla Tacheva [a], Russell L. Chin [a]

[a] Peripheral Neuropathy Center, Department of Neurology, Weill Cornell Medical College, New York, NY, USA
[b] Department of Neurology, Beth Israel Deaconess Medical Center, Boston, MA, USA

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HIGHLIGHTS

- The normal duration of dCMAP recording from TA was determined to be 14 ms.
- The prolonged dCMAP duration from TA is a useful feature in diagnosing CIDP.
- Coexisting axon loss may mask demyelinating features in distal NCS studies.

ABSTRACT

Objective: To assess the duration of the distal compound muscle action potential (dCMAP) recording from the tibialis anterior (TA) as a supportive electrodiagnostic feature in chronic inflammatory demyelinating polyneuropathy (CIDP).
Methods: We performed peroneal motor conduction studies with recording from the TA in 35 CIDP patients, 30 normal controls, and 21 disease controls. The normal cut-off for the TA dCMAP duration was determined to be 14 ms.
Results: Prolonged TA dCMAP durations were detected in 34% of CIDP patients (12/35) and in 33% (2/6) of patients in whom only one demyelinating lesion was identified by conventional motor conduction studies. Prolonged TA dCMAP durations were present in 28% (5/18) of patients with normal duration dCMAPs recorded from the abductor hallucis (AH) and in 42% (5/12) of patients with normal duration dCMAPs recorded from the extensor digitorum brevis (EDB). In patients with AH or EDB dCMAP amplitudes <1 mV, TA dCMAP durations were prolonged in 28% and 23% of patients, respectively.
Conclusions: Determination of TA dCMAP duration appears to be useful for detecting demyelination in CIDP, especially when there is significant coexisting axon loss.
Significance: In patients with potential CIDP and limited electrodiagnostic abnormalities by routine studies, the finding of additional demyelinating findings, such as increased TA dCMAP duration, could allow for improved diagnostic sensitivity.

1. Introduction

The diagnosis of chronic inflammatory demyelinating polyneuropathy (CIDP) requires demonstration of primary demyelinating abnormalities by electrophysiologic or nerve biopsy studies in patients with a compatible clinical presentation (De Sousa et al., 2009; Latov, 2002). The hallmark of CIDP is multifocal demyelination, but the number, type and location of the demyelinating lesions is variable among patients and subtypes of CIDP (De Sousa et al., 2009; Saperstein et al., 2001). Prolonged duration of the distal compound muscle action potential (dCMAP) was added as

Abbreviations: AH, abductor hallucis; CIDP, chronic inflammatory demyelinating polyneuropathy; CMAP, compound muscle action potential; dCMAP, distal compound muscle action potential; EDB, extensor digitorum brevis; TA, tibialis anterior; TA study, peroneal motor conduction study with recording from TA.

* Corresponding author at: Department of Neurology, Beth Israel Deaconess Medical Center, Shapiro 8, 330 Brookline Ave., Boston, MA 02215, USA. Tel.: +1 617 667 4382.
E-mail address: hnodera@bidmc.harvard.edu (H. Nodera).

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an electrodiagnostic feature of CIDP (Thaisetthawatkul et al., 2002; Isose et al., 2009), likely reflecting distal demyelination. However, the dCMAP duration is difficult to assess if the CMAP amplitudes are severely low or absent, as may occur with severe secondary axonal degeneration in some cases of CIDP (Bouchard et al., 1999; Harbo et al., 2008). As axonal loss in CIDP typically occurs in a length-dependent manner, we examined the CMAP duration recorded from the tibialis anterior after stimulation of the peroneal nerve at the fibular head and knee (a technique used in patients with suspected peroneal neuropathy), to determine if additional demyelinating features could be detected in patients with CIDP (Brown and Watson, 1991; van Dijk et al., 1991).

2. Subjects and methods

2.1. Subjects

Subjects were prospectively evaluated at the Peripheral Neuropathy Center of the Weill Cornell Medical College between April 2009 and March 2010. IRB approval was obtained and subjects gave informed consent. The subjects were divided into three categories:

(1) Patients with CIDP: Thirty-five patients were considered to have typical CIDP (with a symmetric phenotype) if they met electrodiagnostic criteria for "Definite" or "Probable CIDP" and inclusion criteria for "Typical CIDP" (EFNS/PNS, 2010). Six of the 35 patients had only one demyelinating lesion identified by conventional nerve conduction studies of six motor nerves (bilateral tibial, bilateral peroneal [EDB recording], unilateral median, and unilateral ulnar nerves), meeting the electrodiagnostic criteria for "Possible CIDP". These six patients, however, were classified as "Probable" or "Definite CIDP" by having one or two supportive criteria, respectively (EFNS/PNS, 2010). Those that had concomitant diseases were excluded (EFNS/PNS, 2010). The mean and median durations of neuropathic symptoms were 74.8 and 45.0 months (range 3–360 months).
(2) Disease controls: This group was comprised of 21 patients who demonstrated evidence of peripheral axonal degeneration or neuronopathy by electrodiagnostic studies. None of them had electrodiagnostic evidence of demyelination in the upper or lower extremities by conventional studies. The diagnoses included: idiopathic sensorimotor axonal polyneuropathy (six patients), lumbosacral polyradiculopathy (six), diabetic polyneuropathy (four), amyotrophic lateral sclerosis (two), copper deficiency polyneuropathy (one), vincristine-associated polyneuropathy (one), and scleroderma-associated polyneuropathy (one).
(3) Normal controls: This group was comprised of 30 subjects who had no neurologic symptoms or signs.

2.2. Nerve conduction studies

Using standard techniques, motor nerve conduction studies were performed of: (1) bilateral tibial nerves recording from the abductor hallucis (AH), (2) bilateral peroneal nerves recording from the extensor digitorum brevis (EDB), (3) unilateral median nerve recording from the abductor pollicis brevis, and (4) unilateral ulnar nerve recording from the abductor digiti minimi. Median and ulnar nerve conduction studies were performed on the more symptomatic side or on the right side if symptoms were symmetric. Orthodromic sensory nerve conduction studies were performed on bilateral sural, unilateral median and unilateral ulnar nerves. Demyelination was determined based on previously-published criteria (Magda et al., 2003) except that the finding of absent F waves was excluded as a sign of demyelination because of the potential for inclusion of a proximal neuropathic process such as radiculopathy and the potential difficulty of separating A waves from F waves.

For the peroneal nerve conduction study with recording from the TA, CMAPs were recorded with 1-cm diameter surface electrodes on the more symptomatic side or on the right side if symptoms were symmetric. The active recording electrode was attached to the midpoint of the muscle belly and the reference electrode was placed on the bony surface of the tibia about 5 cm distal to the active electrode (Nandedkar and Barkhaus, 2007). The ground electrode was placed between the cathode and recording electrodes. Distal surface stimulation was performed with the cathode slightly posterior and inferior to the fibular head, distal to the common compression site. Above-knee stimulation was performed approximately 10 cm proximal to the below-fibular head stimulation site and slightly medial to the biceps femoris tendon. If this initial setting demonstrated abnormally low response amplitudes or complex waveforms with multiple negative phases, attempts were made to generate a maximal negative deflection by increasing stimulus intensity, adjusting stimulator location and making minor adjustments of the active recording electrode (less than 2 cm from the original location). Supra maximal stimulation up to 100 mA with pulse duration of 1 ms was used.

All recordings were performed with a Viking Select machine (Nicolet, Madison, Wisconsin, USA). The equipment settings used for the recording were as follows: sensitivity, 5 mV/division (adjusted if necessary); low frequency filter, 2 Hz; high frequency filter, 10 kHz; sweep speed, 5 ms/division. Skin surface temperature was recorded over the distal leg for tibial and peroneal nerve recordings and over the distal forearm for median and ulnar nerve recordings. Temperatures were maintained at >31 °C in the legs and >32 °C in the arms with the use of a heating pad and a blanket. Two technicians performed nerve conduction studies in all the groups (performing 19 and 16 patients with CIDP, respectively).

The dCMAP duration was defined as the time period from onset of the first negative deflection to return to baseline of the last negative deflection (Isose et al., 2009; Thaisetthawatkul et al., 2002). The cut-offs for dCMAP durations of routine nerve conduction studies were: 6.6 ms (median), 6.7 ms (ulnar), 7.6 ms (peroneal [recording from EDB]), and 8.8 ms (tibial) (EFNS/PNS, 2010; Isose et al., 2009). All latency and dCMAP duration measurements were made by one of the authors (HN), who was blinded to the patient name and diagnosis, at a sensitivity of 100 μV/cm to allow for accurate visualization of the waveforms (Thaisetthawatkul et al., 2002). Other potentially important TA variables such as comparison of proximal to distal CMAP areas, side-to-side variation, and distal latency were not evaluated because of the potential presence of peroneal neuropathy at the knee, the relative lack of asymmetry in typical CIDP, and non-uniform distances between the stimulating and recording electrodes.

Statistical analysis was performed using SPSS (Chicago, USA). Kolmogorov–Smirnov two-sample comparison test was used for comparison between the groups. Chi-square or Fisher's exact test was used for probability. A P value <0.05 was considered to be statistically significant.

3. Results

Table 1 summarizes the results of the peroneal motor nerve conduction studies with recording from the TA. In comparison to the normal controls, the CIDP group was older and comprised of more males. The disease control group was similar to the CIDP group in age distribution, but included a higher percentage of fe-