Clinical Neurophysiology 126 (2015) 1805–1810

Contents lists available at ScienceDirect

Clinical Neurophysiology

journal homepage: www.elsevier.com/locate/clinph

Effects of low frequency filtering on distal compound muscle action potential duration for diagnosis of CIDP: A Japanese–European multicenter prospective study

Satsuki Mitsuma [a], Peter Van den Bergh [b], Yusuf A. Rajabally [c], Vinciane Van Parijs [b], Darren Martin-Lamb [c], Masahiro Sonoo [d], Akira Inaba [e], Toshio Shimizu [f], Sagiri Isose [a], Yasunori Sato [g], Tetsuo Komori [h], Sonoko Misawa [a], Satoshi Kuwabara [a,*], The Tokyo Metropolitan Neuromuscular Electrodiagnosis Study Group [1]

[a] Department of Neurology, Chiba University Hospital, Chiba, Japan
[b] Institute of Neuroscience, Neuromuscular Reference Centre, University Hospitals St-Luc, University of Louvain, Brussels, Belgium
[c] Department of Neurophysiology, University Hospitals of Leicester, Leicester, UK
[d] Department of Neurology, Teikyo University School of Medicine, Tokyo, Japan
[e] Department of Neurology, Kanto Central Hospital, Tokyo, Japan
[f] Department of Neurology, Tokyo Metropolitan neurological Hospital, Tokyo, Japan
[g] Clinical Research Center, Chiba University Hospital, Chiba, Japan
[h] Department of Neurology, National Hakone Hospital, Hakone, Japan

ARTICLE INFO

Article history:
Accepted 15 November 2014
Available online 27 December 2014

Keywords:
Chronic inflammatory demyelinating polyneuropathy
CIDP
Demyelination
Distal compound muscle action potential duration
Electrodiagnosis

HIGHLIGHTS

- The duration of the distal compound muscle action potential (DCMAP) largely depends on low frequency filter settings.
- The effects of low frequency filters on DCMAP duration have been systematically studied in a large number of healthy subjects and typical CIDP patients.
- We have provided the reference data of DCMAP duration using different low frequency filters, as widely available for most EMG laboratories.

ABSTRACT

Objective: The duration of the distal compound muscle action potential (DCMAP) is a useful index to detect demyelination in the distal nerve segments. However in published electrodiagnostic criteria for chronic inflammatory demyelinating polyneuropathy (CIDP), the cut-off values of DCMAP duration are defined using an EMG low frequency filter of only 20 Hz. We aimed to provide widely-available reference data using several low cut filters.
Methods: In 13 Japanese and European tertiary centers, DCMAP duration data using 2, 5, 10, and 20 Hz low frequency filters were prospectively collected from 147 normal controls, 59 patients with typical CIDP, and 100 with diabetic polyneuropathy. Optimal cut-off values were calculated with receiver-operating characteristic curves, offering 100% specificity versus normal controls.
Results: The higher low frequency filter was associated with significantly shorter DCMAP duration in all groups. For CIDP diagnosis, the calculated cut-off values had a sensitivity ranging from 51% to 66%, and a specificity versus diabetic neuropathy from 96% to 98%.
Conclusions: Our results show that DCMAP duration is largely dependent on low frequency filter settings, but is a useful index for CIDP diagnosis when the cut-off values are properly determined at each filter setting.

* Corresponding author at: Department of Neurology, Graduate School of Medicine, Chiba University, 1-8-1 Inohana, Chuo-ku, Chiba 260-8670, Japan. Tel.: +81 43 222 7171x5414; fax: +81 43 226 2160.
E-mail address: kuwabara-s@faculty.chiba-u.jp (S. Kuwabara).
[1] See Appendix A.

http://dx.doi.org/10.1016/j.clinph.2014.11.027

Significance: Our data provide the systematic reference values of DCMAP duration for CIDP diagnosis available for most EMG laboratories.

1. Introduction

The diagnosis of chronic inflammatory demyelinating polyneuropathy (CIDP) is based on a combination of specific clinical, electrodiagnostic, CSF, and other laboratory tests, and currently the diagnostic criteria proposed by the European Federation Neurological Societies/Peripheral Nerve Society (EFNS/PNS) are most frequently used for the diagnosis of CIDP (Hughes et al., 2006; Van den Bergh et al., 2010). Whereas multifocal demyelination is a diagnostic hallmark of CIDP, the distal nerve terminals, as well as the nerve roots, where the blood–nerve barrier is anatomically deficient, are preferentially affected, particularly in the classical form of CIDP that is termed as "typical CIDP" in EFNS/PNS criteria (Dyck et al., 1994; Kuwabara et al., 2002). Therefore it is reasonable that the criteria include prolongation of distally-evoked compound muscle action potential (DCMAP) duration as one criterion.

Prolonged DCMAP duration (i.e., abnormal temporal dispersion of the distal CMAP) has been proposed to be a useful index that reflects demyelination in the distal nerve segments for the diagnosis of CIDP (Thaisetthawatkul et al., 2002; Cleland et al., 2003). The DCMAP duration >9 ms in any one motor nerve, was added in the original 2005 EFNS/PNS criteria (Hughes et al., 2006), but the absolute cut-off value of "9 ms" for any motor nerve was based on only one study that included 23 patients with CIDP (Thaisetthawatkul et al., 2002). In the revised 2010 EFNS/PNS criteria, the optimal cut-off values for DCMAP duration prolongation in each nerve (6.6–8.8 ms according to the nerve), obtained from a large cohort of CIDP patients and healthy controls were provided (Van den Bergh et al., 2010; Isose et al., 2009). The cut-off values were determined using a low frequency EMG filter of 20 Hz, but DCAMP duration is expected to be largely affected by low-frequency filer setting, and various setting are used among laboratories, ranging from 2 Hz to 20 Hz (Rajabally et al., 2012). Moreover, effects of low frequency filters on DCAMP duration have not been systematically studied (Isose et al., 2014). We aimed to establish the effects of filter settings, and to provide optimal cut-off values for DCAMP duration at 2–20 Hz low frequency filters in an international multicenter study.

2. Methods

2.1. Subjects

We prospectively collected electrophysiological data from a total of 306 subjects in 9 Japanese and 2 European (Belgium and UK) tertiary neurology centers; 147 normal controls (66 men, mean age 40 years, range 16–85 years), 59 patients with typical CIDP (24 men, mean age 53 years, range 11–84 years), and 100 with diabetic polyneuropathy (43 men, mean age 66 years, range 38–86 years). All normal controls were healthy volunteers without clinical and electrophysiological evidence of peripheral neuropathy. All typical CIDP patients fulfilled revised EFNS/PNS clinical (symmetric symptoms, proximal as well as distal muscle weakness, and areflexia in all 4 limbs) and electrodiagnostic criteria (Van den Bergh et al., 2010). Variants of CIDP, such as Lewis-Sumner syndrome/asymmetric CIDP, pure motor or sensory CIDP, and focal variants were excluded. A diabetic neuropathy was defined on the basis of known diabetes mellitus, the presence of symmetric sensory-dominant polyneuropathy, and exclusion of other cause for polyneuropathy. Coincidental carpal tunnel syndrome was carefully excluded using median–ulnar comparative sensory nerve conduction studies.

2.2. Electrophysiology

Motor nerve conduction studies were conducted on the median, ulnar, peroneal, and tibial nerves using conventional procedures (Kimura, 2001). Stimulus sites were 3 cm proximal to the wrist crease in median and ulnar nerve studies, just lateral to the medial malleolus for tibial nerve studies, and intermalleolus portion (between the extensor digitorum longus and extensor halluces tendons) for peroneal nerve studies. Standard EMG high-cut filter setting was 10 kHz, and low frequency filter was set as 2, 5, 10, and 20 Hz, whereas 5 Hz recording was not performed in one laboratory (Belgium) because of the difficulty in setting on the EMG machine (22 normal subjects, 15 CIDP, and 19 diabetic patients). DCMAP duration was defined as the time period from onset of the initial negative phase to return to baseline of the last negative deflection of the CMAP, at sensitivity of 500 μV/division for precise cursor positioning, as described elsewhere (Isose et al., 2009).

2.3. Statistical analyses

The effects of low frequency filter on DCMAP duration were evaluated with Jonckheere–Terpstra test (Jonckheere, 1954). The receiver-operating characteristic (ROC) curve was obtained by plotting the sensitivity of all possible cut-off points for a test on the Y-axis against "1-specificity" (false positivity) on the X-axis (Akobeng 2007; Perkins et al., 2006; Fluss et al., 2005; Schisterman et al., 2001). The area under the ROC curve (AUC) was estimated using a form of the trapezoid method, and 95% confidence interval of the AUC was estimated by the bootstrap method approach with 100,000 re-sampled datasets. One criterion for

Table 1
Distal CMAP duration in normal subjects and patients with CIDP or diabetic neuropathy.

		Low frequency filter			
		2 Hz	5 Hz	10 Hz	20 Hz
Normal (n = 147)					
Median	(ms)	6.1 (0.9)	5.8 (0.8)	5.6 (0.8)	5.1 (0.7)
Ulnar	(ms)	6.5 (1.0)	6.1 (0.8)	6.0 (0.9)	5.4 (0.7)
Peroneal	(ms)	6.1 (0.9)	6.0 (0.9)	5.8 (0.8)	5.5 (0.8)
Tibial	(ms)	5.6 (0.9)	5.5 (0.9)	5.5 (0.9)	5.3 (0.9)
Typical CIDP (n = 59)					
Median	(ms)	8.3 (3.0)*	8.2 (2.5)*	7.6 (2.7)*	7.1 (2.5)*
Ulnar	(ms)	8.5 (2.8)*	8.0 (2.2)*	7.5 (1.9)*	7.0 (1.7)*
Peroneal	(ms)	8.4 (3.5)*	8.6 (3.4)*	7.8 (2.9)*	7.3 (2.7)*
Tibial	(ms)	8.8 (4.1)*	8.8 (4.3)*	8.4 (4.0)*	7.9 (3.9)*
Diabetic neuropathy (n = 100)					
Median	(ms)	5.9 (1.0)	5.7 (0.9)	5.5 (0.8)	5.1 (0.8)
Ulnar	(ms)	6.3 (0.9)	6.0 (0.8)	5.7 (0.8)	5.3 (0.7)
Peroneal	(ms)	5.9 (1.2)	5.8 (1.3)	5.6 (1.2)	5.2 (1.0)
Tibial	(ms)	5.7 (0.9)	5.5 (0.7)	5.5 (0.9)	5.3 (0.9)

Data are given as mean (SD); *p < 0.01 compared with both the normal and diabetic groups.
The higher low-cut filter was associated with significantly shorter duration. (Jonckheere–Terpstra test; see text).