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Relation between distal motor latency delay and sensory action potential absence of the median nerve in carpal tunnel syndrome☆

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ABSTRACT

Objective: To elucidate the cutoff value for distal motor latency (DML) at which sensory nerve action potentials (SNAPs) are absent in carpal tunnel syndrome (CTS) patients.
Method: We examined 157 hands in 129 patients with CTS retrospectively. We classified the patients according to whether SNAPs were successfully obtained. Group A consisted of hands with SNAPs, while Group B consisted of hands without SNAPs. The cutoff value for DML was determined by receiver-operating characteristic curve analysis. We enrolled 130 hands with CTS for the analysis, because measurements were successful in 130 hands for compound muscle action potentials and in 82 hands for SNAPs from a total of 157 hands investigated.
Results: A significant correlation was observed between DML and SCV ($P<0.0001$, $R^*2 = 0.40$). The most discriminative cutoff value for DML was 7.7 ms, resulting in a sensitivity of 79.6% and specificity of 79.3%.
Conclusion: Cases in which SNAPs are evoked despite a DML longer than 7.7 ms should raise suspicion.

1. Introduction

Electrophysiological examination has been widely used for diagnosis of carpal tunnel syndrome (CTS) and evaluation of its severity. [1–3] In CTS the distal motor latency (DML) to abductor pollicis brevis (APB) muscle and the sensory nerve conduction velocity are inversely correlated. A disproportionate abnormality of one measure in relation to the other may therefore raise the possibility that another disorder is present. This study aims to establish the value of DML at which the sensory nerve action potentials (SNAPs) may usually be expected to be unrecordable.

1.1. Patients and method

1.1.1. Patients

This study was performed through Yamaguchi Rosai Hospital and Ube Kosan Central Hospital and the data were collected retrospectively. We examined 157 hands in 129 patients with CTS who were diagnosed on the basis of clinical symptoms and with support also from electrophysiological investigation. There were 39 men and 79 women with an average age of 68.5 years (range, 30-93). All patients underwent a nerve conduction study at the initial visit. Because measurements were successful in 130 hands for CMAPs and in 82 hands for SNAPs from a total of 157 hands investigated, we enrolled 130 hands and excluded 27 hands to determine the cutoff value for statistical analysis. Written informed consent with approval from our institutions was obtained from all patients prior to the electrophysiological procedures. Patients who fulfilled the criteria described below were included in the study.

A diagnosis of CTS was established based on the presence of either or both of the following symptoms: 1) nocturnal pain and paresthesia, 2) symptoms worsen by manual activities such as driving a car, read a book or sewing. In addition all patients had abnormal nerve conduction studies consistent with CTS by AANEM

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criteria [1] and without evidence of ulnar neuropathy or polyneuropathy.

Patients who had cervical myelopathy, concomitant radiculopathy, glove and stocking sensory symptoms, diabetes mellitus, motor neuron disease or peripheral neuropathy were excluded.

We classified the patients according to whether SNAPs were successfully obtained. Group A consisted of hands with SNAPs, while Group B consisted of hands without SNAPs.

1.1.2. Nerve conduction study

Motor nerve conduction for the median nerve was measured using the Neuropack S1 (Nihon Kohden, Tokyo, Japan).

For measurement of DML of APB and amplitudes of CMAPs of APB, the median nerves were stimulated 60 mm proximal to the APB muscle belly across the wrist. For measurement of SCV of the median nerve and amplitudes of sensory nerve action potentials (SNAPs) by antidromic stimulation across the wrist, the median nerves were stimulated 100–140 mm proximal to the index finger and recording electrodes were placed over the proximal phalanx on the index finger, with the reference electrode placed 30 mm distally. SNAPs were recorded without averaging. We always checked the reproducibility of SNAPs, particularly if SNAPs were low. We considered absent the SNAP when the onset was not detectable after more than 30 stimulations. Measurement of CMAPs and SNAPs included the negative peak amplitude from baseline to peak. The skin temperature of the arm was maintained at >32 °C using an infrared lamp if necessary.

The way of nerve conduction study was standardized in all institutions as described above.

1.2. Statistical analysis

Descriptive statistics, including the mean and standard deviation (SD), were applied to all CMAPs and SNAPs values. Regression analysis was used to evaluate correlations between DML and SCV. (dependent variables: DML, independent variable: SCV)

The Mann-Whitney *U* test for unpaired data was used to compare DML between Groups A and B and Spearman rank correlation coefficients for interrelation analysis. The diagnostic efficacy of DML in distinguishing the two groups was evaluated by receiver-operating characteristic (ROC) curve analysis, which corresponds to non-parametric method and is not affected by the distribution pattern of DML values. The area under the curve (AUC) and its 95% confidence intervals [4] was computed to show an overall efficacy of the distinction. The optimal cutoff value for the distinction was determined as a DML values at the intersection of the sensitivity (Sn) and specificity (Sp) curves: Sn or Sp (on the Y-axis) vs. consecutive cutoff value of DML (on the X-Axis).

All P-values < 0.05 were considered to be statistically significant. Statistical analysis was performed using the statistical program stat flex (Artech, version 5.0, Osaka, Japan).

Table 1
Electrophysiological date on patients.

	Group A (mean± SD)	Group B	P value (Group A vs Group B)
age	64.6 ± 12.7	73.4 ± 9.7	P < 0.0001
DML (ms)	6.39 ± 1.8	10.55 ± 4.02	P < 0.0001
SCV (m/s)	33.24 ± 11.12		

SD, standard deviation; DML, distal motor latency; SCV, sensory conduction velocity.

2. Results

2.1. CMAPs and SNAPs in patients

Results for CMAPs and SNAPs in Group A and B are shown in Table 1. Measurement of CMAPs in Group B was successful in 48 hands out of 75. Among 157 symptomatic hands, 154 hands (98.7%) showed at least one delayed electrophysiological study (DML of APB or SCV of the index finger). There was a significant difference (P < 0.0001) in DML between Group A (n = 82, 6.39 ± 1.8 ms (range, 3.21-13.5 ms)) and B (n = 48, 10.55 ± 4.02 ms (range, 4.3-25.85 ms)). The mean age of patients in Group B (73.4 ± 9.7 years) was significantly higher (P = 0.0001) than in Group A (64.6 ± 12.4 years).

Regression analysis was used to express the relationship between DML and SCV as a correlation coefficient and DML was expressed with following formula:

(P < 0.0001, r = −0.61 (95% confidental interval, −0.42 to −0.76), R*2 = 0.40, where R*2 is the coefficient of determination adjusted for degree of freedom, Fig. 1)

2.2. ROC analysis to determine the cutoff value for DML

The ROC analysis in Fig. 2 showed the degree of distinction of the two groups in term of area under the curve was 0.873 (95% confidential interval [CI], 0.807-0.931) (n = 130). The optimal cutoff

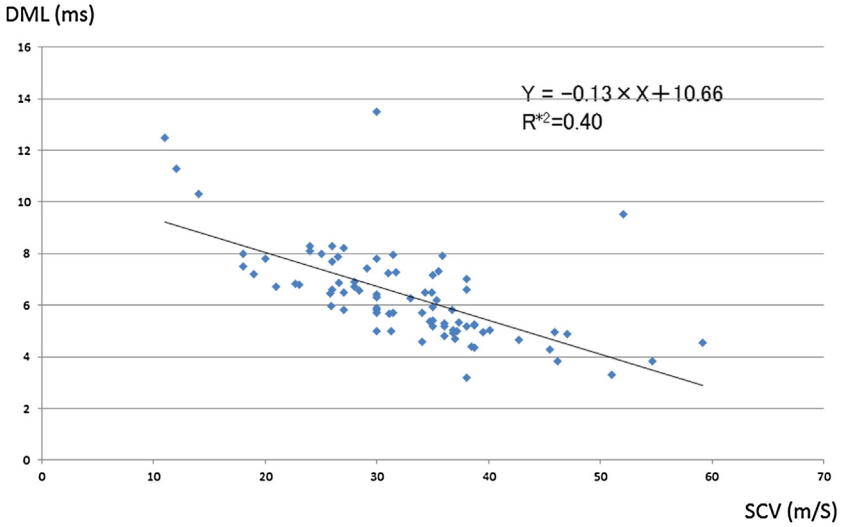

Fig. 1. Scatter plots of sensory nerve action potentials amplitudes with distal terminal latency in group A. Arrow demonstrates the cases who showed obvious discrepancy from the correlation between SCV and DML. Y = −0.13X + 10.66, R*2 = 0.40.