

The relationship between nerve conduction study and clinical grading of carpal tunnel syndrome

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ABSTRACT

Purpose. To conduct a median nerve conduction study on patients with carpal tunnel syndrome and investigate the relationship between nerve conduction study parameters and clinical grading.

Methods. A nerve conduction study was performed on 60 upper limbs of 37 patients with idiopathic carpal tunnel syndrome, and the relationship between the clinical grade and various study parameters was assessed.

Results. The amplitude of the sensory nerve action potential and the motor nerve action potential differed according to clinical grading, but this pattern was not seen for sensory nerve conduction velocity, motor nerve conduction velocity, or motor nerve terminal latency and clinical grading.

Conclusion. The amplitude of the sensory nerve action potential and motor nerve action potential reflect the

functional state of axons, and are useful parameters for assessing clinical grading based on nerve conduction velocity.

Key words: *carpal tunnel syndrome; electrophysiology; neural conduction*

INTRODUCTION

Carpal tunnel syndrome (CTS) is a common condition, characterised by entrapment neuropathy of the median nerve in an upper extremity. Clinical manifestations are the most important findings for diagnosis and the assessment of therapeutic effects, but objective indicators, such as electrophysiological findings, are valuable supplementary tools.¹⁻³ Numerous studies have been conducted on the diagnostic findings on electrophysiology, and although there have been

various reports on CTS grade assessment, no specific method has been established.⁴⁻⁹ This study reports the findings of median nerve conduction studies (NCS) in patients with CTS, and investigation of the relationship between NCS parameters and clinical grading.

MATERIALS AND METHODS

Over a 3-year period, 60 upper limbs of 37 patients with idiopathic CTS were examined, 8 upper limbs of 7 men and 52 upper limbs of 30 women. Ages ranged from 14 to 88 years, with a mean age of 60.7 years. A total of 14 patients had unilateral CTS (right upper limb in 5 patients, and left upper limb in 9 patients), and 23 patients had bilateral CTS. A diagnosis of CTS was made when the following 6 criteria were met:

- (1) persistent sensory symptoms;
- (2) abnormal static 2-point discrimination (>6 mm);
- (3) diminished light touch sensation or greater impairment on the Semmes-Weinstein test;
- (4) muscle wasting;
- (5) positive provocative signs, such as the presence of Phalen's and Tinel's signs; and
- (6) meeting the American Association of Electrodiagnostic Medicine electrophysiological diagnostic criteria.¹⁰

Electrophysiological studies were performed utilising an electromyography machine (MEB-7102; Nihonkohden, Tokyo, Japan). Studies were conducted in a shielded room, ensuring that the patient's skin temperature was at least 32°C. Sensory nerve conduction velocity (SCV) was measured first by placing a recording ring-electrode on the base of the ring finger. Then, the median nerve was stimulated at

the wrist 13 cm proximal to the recording electrode, and the antidromic sensory nerve action potentials (SNAPs) were recorded and measured. Elbow-to-wrist motor nerve conduction velocity (MCV) and terminal latency (TL) were measured by placing a surface electrode on the muscle belly of the abductor pollicis brevis, stimulating the median nerve at the wrist 7 cm proximal to the electrode, and eliciting compound muscle action potentials (CMAPs). The onset latency of the CMAP was recorded as the TL, and the electrical potential difference between the lowest point and the highest point was recorded as the amplitude of the CMAPs and the SNAPs. The clinical grade of CTS was designated as mild, moderate, or severe based on symptoms and signs, according to Mackinnon's classification criteria.¹²

Values obtained for each severity group were expressed as mean and standard deviation. The Fisher's exact test and the Chi squared test were used to compare the results between the mild, moderate, and severe CTS groups. A p value of less than 0.05 was considered statistically significant. In addition, the relationship between NCS and clinical grading of CTS was examined by calculating the linear regression.

RESULTS

The clinical grading of CTS was mild in 21 upper limbs, moderate in 21 upper limbs, and severe in 18 upper limbs. The relationship between clinical grade and SCV was as follows: 35.4±2.16 m/s for the mild group, and 23.1±3.95 m/s for the severe group. There was no significant difference between the 2 groups. However, the amplitude of SNAPs for the mild group (6.61±1.69 µV) was significantly greater than that for the severe group (0.43±0.29 µV) [p<0.01; Fig. 1]. The

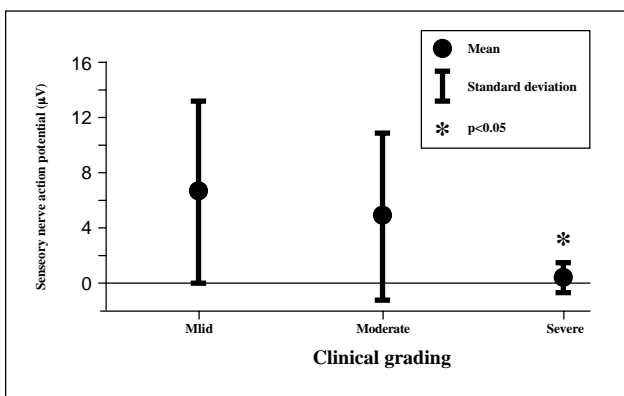


Figure 1 Relationship between sensory nerve action potential and clinical grading.

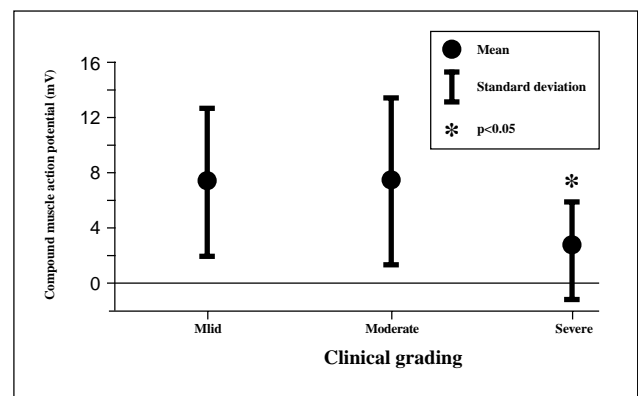


Figure 2 Relationship between compound muscle action potential and clinical grading.

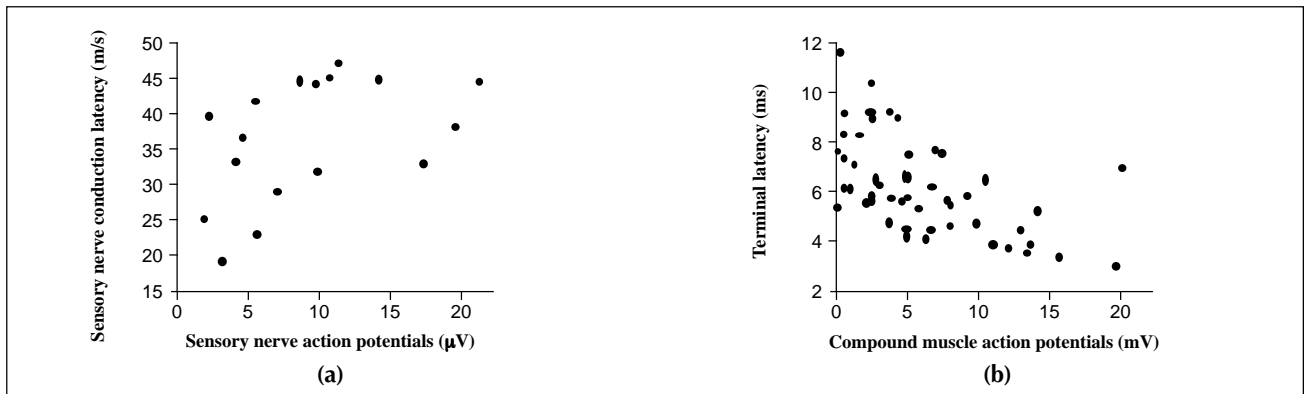


Figure 3 Relationship between nerve conduction velocity and nerve action potentials. Weak positive correlations between (a) sensory nerve conduction latency and sensory nerve action potentials ($R^2 = 0.312$), and (b) between terminal latency and compound muscle action potentials ($R^2 = 0.383$) are revealed.

relationship between the clinical grades and MCV was analysed. TL for the mild group (5.73 ± 0.25 ms) was shorter than that for the severe group (7.61 ± 0.70 ms), but there was no statistically significant difference between the 2 groups. There were no significant differences in forearm MCV between the mild and severe groups. The amplitudes of CMAP for the mild, moderate, and severe groups were 7.0 ± 1.14 , 7.10 ± 1.32 , and 2.16 ± 0.78 mV, respectively, with a statistically significant difference evident between the mild and severe groups, and between the moderate and severe groups. As with the SNAP, there was a tendency for a greater reduction of amplitude of the CMAP to be associated with a more severe clinical grade ($p < 0.01$; Fig. 2).

DISCUSSION

In entrapment neuropathy, nerve conduction velocity is generally thought to be a sensitive indicator of the severity of demyelination and ischaemia at the entrapment point. Thus, conduction velocity measurement in CTS is of diagnostic significance. Further, since conduction velocity measurement can identify subclinical lesions, it has particular value in initial diagnosis.^{2,3} However, in segment nerve injuries where a nerve is compressed locally, electrophysiological findings do not necessarily reflect the disease state of the entire nerve (the median nerve in the case of CTS). The results of an electrophysiological study will therefore not always be consistent with clinical findings when CTS is advanced and varying stages of impairment in differing nerve fibres is present. Kaneko et al.¹¹ observed that axonal

degeneration caused only mild delays in conduction velocity, and concluded that conduction velocity did not directly reflect the degree of axonal degeneration.

Several investigators have reported that forearm nerve conduction velocity reflected chronological changes in retrograde degeneration of the median nerve, and that these changes correlated with the clinical grading of CTS.^{5,7} This suggests that electrophysiological studies can identify signs of neurological impairment in the median nerve beyond the carpal tunnel, as degeneration becomes more extensive. In this study, there was a trend towards greater delays in forearm MCV and SCV with increasing severity of clinical grade, but there were no significant differences seen between the 3 severity groups. This finding may reflect the fact that when CTS was pathologically advanced, in many cases neither the SCV nor MCV could be detected. The number of cases where SCV or MCV was not detected was particularly high on elbow stimulation, compared to wrist stimulation, due to the time diffusion phenomenon. As a result, there appeared to be a lower limit in numerically expressing delays in conduction velocity. Furthermore, Mackinnon's classification criteria¹² are based not only on subjective symptoms, but also on the presence or absence of muscular atrophy and sensory impairment, thus making it difficult to accurately assign clinical grades.

Although the amplitudes of SNAPs and CMAPs reflect the functional state of axons, the utility of SNAP/CMAP amplitude for assessing the clinical grading of CTS has not been investigated in previous studies. The primary reason for this is the technical limitation: it is difficult to obtain stable waveforms

suitable for assessment. In this study, there was a weak positive correlation between SCV and SNAP, and between TL and CMAP ($R^2=0.312$ and 0.383 , respectively) [Fig. 3]. The degree of fluctuation in the technical aspects of the electrophysiological studies was minimal, and thus stable waveforms were

obtained. When studies are conducted by a skillful examiner using a consistent method, SNAP/CMAP amplitude provides a better, more reliable indicator of the clinical grading of CTS. This is the most important parameter in NCS for CTS with respect to therapy selection.

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