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Electrodiagnosis of carpal tunnel syndrome in patients with diabetic polyneuropathy

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See Editorial, page 1277

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HIGHLIGHTS

- Diagnosis of carpal tunnel syndrome (CTS) is difficult in patients with diabetic polyneuropathy.
- Distoproximal latency ratio (DPLR) is the best electrodiagnostic test in the diagnosis CTS in diabetic polyneuropathy patients.
- Distoproximal latency ratio (DPLR), median and ulnar sensory latency difference to digit 4 (MUDD4), Wrist–palm median sensory conduction velocity (W-P SCV) and median and radial sensory latency difference to digit 1 (MRDD1) had a higher diagnostic accuracy.

ABSTRACT

Objective: Diagnosis of carpal tunnel syndrome (CTS) is difficult in patients with diabetic polyneuropathy as both conditions may affect median nerve conduction in a similar manner. There is no agreement about which electrodiagnostic tests are more efficient in determining CTS accurately in these patients. In this study, we aimed to define the best electrodiagnostic test in the diagnosis of CTS in diabetic polyneuropathy patients.
Methods: We prospectively investigated 72 patients with CTS (140 hands), 32 patients with diabetic polyneuropathy without CTS (61 hands), 35 patients with diabetic polyneuropathy with CTS (62 hands) and 43 healthy controls (86 hands). Standard nerve conduction studies, segmental and comparative median nerve conduction tests were performed in all subjects. Cut-off values, sensitivities and specificities of each test for the diagnosis of CTS in diabetic polyneuropathy patients were determined by using receiver operating characteristic (ROC) curve.
Results: Distoproximal latency ratio (DPLR) with a sensitivity of 90% and specificity of 81% for the cut-off value of 1 and median and ulnar sensory latency difference to digit 4 (MUDD4) with a sensitivity of 90% and specificity of 85% for the cut-off value of 0.35 showed the highest sensitivity and specificity in the diagnosis of CTS in diabetic polyneuropathy patients among all nerve conduction tests. Wrist–palm median sensory conduction velocity (W–P SCV) and median and radial sensory latency difference to digit 1 (MRDD1) also showed high sensitivity and specificity.
Conclusions: Segmental median nerve conduction studies like DPLR and W–P SCV and sensory comparative tests such as MUDD4 and MRDD1 in combination with standard nerve conduction tests should result in more accurate diagnosis of CTS in diabetic polyneuropathy patients.
Significance: These results could be helpful to overcome the diagnostic difficulty of CTS in patients with diabetic polyneuropathy.

1. Introduction

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy caused by the compression of the median nerve as it passes through the carpal tunnel at the wrist (Bosch and Smith,

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2004; Dumitru and Zwarts, 2002; England, 1999; Sternbach, 1999; Werner and Andary, 2002). Diagnosis is usually based on typical symptoms and signs in conjunction with objective electrodiagnostic findings. Although electrodiagnostic studies have been considered highly sensitive and specific for the diagnosis of CTS, standard electrodiagnostic techniques may fail to detect some CTS cases in patients with normal median sensory and motor distal latencies or with an additional polyneuropathy (Jablecki et al., 1993, 2002). Various electrodiagnostic techniques have been used to improve the sensitivity of motor and sensory conduction studies in such cases (Chang et al., 2002; Jablecki et al., 2002; Kaul and Pagel, 2002; Padua et al., 1996; Pyun et al., 2005; Sander et al., 1999; Sheu et al., 2006).

CTS has been reported to be more frequent in diabetic polyneuropathy patients than in the general population (Perkins et al., 2002; Vinik et al., 2004). Clinical diagnosis of CTS is difficult in patients with diabetic polyneuropathy as polyneuropathy symptoms may mimic those of CTS in clinical practice. Since CTS and diabetic polyneuropathy may produce similar abnormalities in median nerve conduction, the use of standard electrophysiological diagnostic criteria in these patients results in a high rate of false positive diagnosis (Hansson, 1995; Kim et al., 2000; O'Brian and Massey, 1979; Perkins et al., 2002; Vinik et al., 2004). On the other hand, attributing the changes in median nerve conduction to polyneuropathy alone because of the uncertainty of the diagnostic criteria of CTS in these patients may also lead to a false negative diagnosis. Diagnosis is important for appropriate treatment planning. Electrodiagnostic criteria for the diagnosis of CTS in patients with an underlying diabetic polyneuropathy have not been established. Several electrodiagnostic techniques have been proposed to determine CTS in patients with diabetic polyneuropathy but there is no consensus on which of these tests is most reliable (Imada et al., 2007; Kim et al., 2000; Perkins et al., 2002; Stamboulis et al., 2005; Vogt et al., 1997).

In this prospective study, we aimed to determine the most sensitive and specific electrodiagnostic test in the diagnosis of CTS in patients with diabetic polyneuropathy.

2. Methods

2.1. Patients

Patients aged 18–70 years, referred to the Karadeniz Technical University Medical Faculty Neurophysiology Laboratory between November 2006 and June 2007 with suspected diabetic polyneuropathy or CTS, were screened for the study. The ethical committee approved the study and informed consent was obtained from each subject.

Patients with cervical radiculopathy, thoracic outlet syndrome, a history of previous median nerve surgery and trauma, prominent atrophy of the abductor pollicis brevis (APB) muscle, hereditary polyneuropathy, systemic disease that can lead to polyneuropathy other than diabetes and symptoms and signs of acute or subacute polyneuropathy were excluded. Diabetes was excluded in the CTS and control groups on the basis of individuals having fasting plasma glucose levels lower than 100 mg dl^{-1} and no diabetes symptoms.

The study consisted of four groups:

(I) CTS group: Patients diagnosed with CTS using clinical and electrophysiological methods.
(II) Diabetic polyneuropathy without CTS group (DMPNP CTS−): Patients diagnosed with polyneuropathy using clinical and electrophysiological methods but who lacked symptoms and signs of CTS.
(III) Diabetic polyneuropathy with CTS group (DMPNP CTS+): Patients diagnosed with polyneuropathy using clinical and electrophysiological methods and with symptoms and signs of CTS.
(IV) Control group: Healthy subjects with normal peripheral nerve conduction studies.

Fig. 1 illustrates the patient flow chart.

Demographic features of patients (age, sex, dominant hand, occupation, systemic or genetic disease, diabetes type and duration and HbA1c levels) and body mass indices (BMIs) were recorded.

All subjects referred to our laboratory with suspected CTS were questioned for CTS symptoms and examined for CTS signs (Investigator 2, VA). Clinical diagnosis of CTS was based on the presence of the following:

(1) At least one of the sensory symptoms (numbness, tingling, burning or pain) in median nerve distribution.
(2) At least one of the provocative or mitigating factors: sleep, sustained position, repetitive actions, hand shaking or hand position change.
(3) At least one of the following signs: Tinel or Phalen's signs, sensory loss or weakness in median nerve distribution (Simovic and Weinberg, 1999; AAN Quality Standards Subcommittee, 1993).

CTS diagnosis was confirmed by electrophysiological tests (Investigator 1, CB). Electrophysiological diagnostic criteria of CTS should include at least two of the following (Stevens, 1997): (a) prolonged distal motor latency of the median nerve greater than 4 ms; (b) prolonged median nerve digit 2 sensory onset latency greater than 2.5 ms; (c) prolongation of the median sensory nerve action potential (SNAP) of digit 2 relative to ulnar SNAP of digit 5 greater than 0.4 ms; and (d) prolongation of median digit 4 sensory response compared to ulnar digit 4 sensory response on set latency of greater than 0.5 ms. The CTS group consisted of clinically diagnosed and electrophysiologically confirmed CTS patients.

All subjects referred to our laboratory with suspected diabetic polyneuropathy were examined for the symptoms and signs of polyneuropathy and underwent the standard nerve conduction tests for electrophysiological confirmation of polyneuropathy (Investigator 1, CB). Polyneuropathy was diagnosed according to the American Academy of Electrodiagnostic Medicine (AAEM) criteria (England et al., 2005). Diabetic polyneuropathy patients were further examined for clinical diagnosis of CTS using the same criteria as those for nondiabetic CTS patients (Investigator 2, VA). Patients were dichotomised into DMPNP CTS+ and DMPNP CTS− groups based on clinical CTS diagnosis.

Patients with absent motor or sensory potentials in the median and ulnar nerves and with mononeuropathy other than CTS in the DMPNP group, and with pathological electrophysiological findings in the ulnar nerve (sensory nerve action potentials with amplitudes of <20 μV, sensory nerve conduction velocities <50 m s^{-1}, motor nerve action potentials with amplitudes of <6 mV, motor nerve conduction velocities <49 m s^{-1}) in the CTS group were excluded.

Investigator 3 (SG), who was blinded to the groups, administered further electrophysiological protocols designed for this study to all eligible patients and controls.

2.2. Electrodiagnostic methods

All electrophysiological recordings were made with a Nihon Kohden 9100 electromyograph at a room temperature of 25 °C. Palmar temperature was maintained at approximately 32 °C using a digital thermometer (Dermatemp 1001). Electrodiagnostic studies were performed on both hands and in one of the lower extrem-