# 多發性周邊神經病變患者前臂段之正中神經傳導研究

Nerve Conduction Studies on the Median Nerve in the Forearm in Patients with Polyneuropathy

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**Abstract**

Careful nerve conduction studies in patients with polyneuropathy can provide useful information for differential diagnosis of the pathophysiological processes and in search of their underlying etiological factors. We systematically studied nerve conduction velocities of the right median nerve with different techniques in 128 normal controls, 19 patients with acute demyelinating polyneuropathy, 36 patients with chronic demyelinating polyneuropathy, and 16 patients with diabetic polyneuropathy. Techniques to study the nerve conduction of the median nerve included motor nerve conduction with measuring the latency of evoked compound muscle action potentials;. sensory nerve conduction with measuring the latency of evoked sensory action potentials; centripetal nerve conduction with measuring the latency of the centripetally recorded nerve action potential; centrifugal nerve conduction with measuring the latency of the centrifugally recorded nerve action potentials; nerve conduction by measuring the latencies of scalp somatosensory evoked potentials to stimulation of the median nerve distally and proximally. We found that nerve conduction velocity (NCV) through motor fiber stimulation was slower than that through any other techniques. In the patients with acute demyelinating polyneuropathy, NCV through centrifugally recorded technique did not slow significantly as compared with that in the normal controls. NCVs from other diagnostic techniques were lower than those in the normal controls. In chronic demyelinating polyneuropathy, NCV obtained from any electrodiagnostic technique was slower than the NCV with comparable technique in the normal controls. The normal controls and the patients with chronic demyelinating polyneuropathy had a same pattern of NCV difference among various electrodiagnostic techniques.

Keywords: polyneuropathy, nerve conduction study, nerve action potential, somatosensory evoked potential

**摘要**

**多發性神經病變多為代謝障礙、營養缺乏、中毒、自體免疫失常、血中蛋白異常或癌症等全身性疾病之一種臨床表徵。若能仔細地分析神經傳導檢查之結果，當有助於探索多發性神經病變之可能病因。**

**本研究共收集128位正常人，19位急性脫髓鞘性多發性神經病變（ADP）患者，36位慢性脫髓鞘性多發性神經病變（CDP）患者及16位糖尿病神經病變患者，針對其右側前臂段之正中神經施予不同之周邊神經傳導評估。所採用之檢查方法為：**

**一、刺激正中神經而在短外展姆肌記錄運動動作電位之運動神經傳導。**
**二、刺激正中神經而在食指記錄感覺動作電位之感覺神經傳導。**
**三、刺激正中神經遠端而在正中神經近端記錄神經動作電位之神經傳導。**
**四、刺激正中神經近端而在正中神經遠端記錄神經動作電位之神經傳導。**
**五、分別刺激正中神經遠端及近端之頭皮記錄體覺誘發電位所得之神經傳導。**

**結果顯示，刺激運動纖維所得之神經傳導速度（NCV）比其他四種方法所得者低。在ADP患者中，記錄神經動作電位的NCV未有明顯改變外，其他四種方法之NCV皆有下降之趨勢。在CDP患者中，所有方法所得之NCV皆比正常組明顯下降，而且和正常人維持相常的分佈趨勢。**

**關鍵詞**

**多發性神經病變、運動神經傳導檢查、感覺神經傳導檢查、體覺誘發電位。**

## Background and Objectives

Peripheral nerve involvement manifested as polyneuropathy is not uncommon in many systemic diseases (1-3). Systemic disease which can cause polyneuropathy include metabolic disorders, nutritional deficiency conditions, autoimmune or allergic disorders, intoxications, paraneoplastic syndromes, or paraproteinemia, etc. (1-4). As polyneuropathy can also be the first presentation of its underlying systemic diseases, hence, a careful work-up for polyneuropathy may provide important hints in etiological diagnosis of the underlying systemic disease. For practical purpose, detailed investigations on the clinical manifestations and analysis of the electrodiagnostic findings are necessary (5-7).

With advanced electrodiagnostic techniques, conductivity or conduction disorders of a peripheral nerve can be precisely evaluated through different approaches. The nerve conduction velocities of the median nerve in the forearm can be studied with at least five electrodiagnostic methods (5-11), as follows: 1. motor nerve conduction by stimulation of the median nerve with measuring the latency of evoked compound muscle action potentials; 2. sensory nerve conduction by stimulation of the median nerve with measuring the latency of evoked sensory action potentials; 3. nerve conduction by stimulation of the median nerve with measuring the latency of the centripetally recorded nerve action potential; 4. nerve conduction by stimulation of the median nerve with measuring the latency of the centrifugally recorded nerve action potentials; 5. nerve conduction by measuring the latencies of scalp somatosensory evoked potentials to stimulation of the median nerve distally and proximally.

In the present study, we applied these five electrodiagnostic techniques to study the median nerve conductivity in patients with polyneuropathy. We correlated these findings with patient's problems.

## Patients and Methods

### I. Case Enrollment

Polyneuropathy patients who had been thoroughly studied and whose underlying etiological factors had already been clarified were enrolled in the present study. The exclusion criteria included:

(1) patients whose age was over 70 years;
(2) patients who had more than one underlying etiological factors;
(3) patients who had co-existed peripheral nerve disease other than polyneuropathy;
(4) patients who had CNS diseases;
(5) patients who had any too severe co-existed systemic or metabolic diseases;
(6) patients who were very sensitive to electric stimulation to the peripheral nerve.

The personal history of each patients was carefully recorded, especially any factors which might affect electrodiagnostic data, such as sex, age, body height, and handedness. Their clinical features including peripheral nerve manifestations were systemically investigated.

### II. Motor conduction study of the median nerve in the forearm

Motor nerve conduction study was undertaken with a Viking IV electromyograph (Nicolet, USA). The active electrode was placed at the belly of the abductor pollicis brevis and the reference electrode at its distal muscle tendon. The median nerve was stimulated distally at the wrist and proximally at the elbow. The stimulus consisted of a square-shaped direct electric current of 0.1msec. The distal distance between the recording electrode and the cathode of stimulator was kept at 7cm. The distance between distal and proximal stimulation was carefully measured. The recording period will be set as 20msec after

stimulation and recording sensitivity at 1, or 2, or 5 millivolts. On the oscilloscope, the latency is measured between the starting point of stimulation artifacts and the take-off point of the evoked compound muscle action potential. A motor nerve conduction velocity (motor NCV) was calculated as:
Motor NCV=distance between distal and proximal stimulation / latency difference between distal and proximal stimulation.

**III. Sensory conduction study of the median nerve in the forearm**

The active ring electrode was placed at the root of the index finger and another ring electrode at the tip of the finger as a reference electrode. The median nerve was stimulated distally at the wrist and proximally at the elbow. The stimulus consisted of a square-shaped direct electric current of 0.1msec. The distal distance between the recording electrode and the cathode of stimulator was set at 15cm. The distance between distal and proximal stimulation was carefully measured. The recording period was set as 20msec after stimulation and recording sensitivity at 2, or 5 or 10 microvolts. An averaging technique to improve the signal-noise ratio was applied if the evoked response was too small and hard to be identified. On the oscilloscope, the latency is measured between the starting point of stimulation artifacts and the take-off point of the evoked sensory action potential. A sensory nerve conduction velocity (sensory NCV) was calculated as:
Sensory NCV=distance between distal and proximal stimulation / latency difference between distal and proximal stimulation.

**IV. Centripetal nerve conduction study of the median nerve in the forearm**

A centripetal nerve conduction study was taken with the same electromyograph. The active disc electrode was placed at the elbow over the median nerve and a referential distal electrode 3cm proximal to the active electrode along the median. The median nerve was centripetally stimulated at the wrist with anode more close to the palm. The stimulus consisted of a square-shaped direct electric current of 0.1msec. The distance between the recording electrode and the cathode of stimulation site was carefully measured. The recording period was set as 20msce after stimulation and recording sensitivity at 2, or 5 or 10 microvolts. An averaging technique to improve the signal-noise ration was applied if the evoked response was too small and hard to be identified. On the oscilloscope, the latency was measured between the starting point of stimulation artefacts and take-off point of the evoked nerve action potential. A centripetal nerve conduction velocity (NCV) was calculated as:
Centripetal NCV= distance between anode and active electrodes / latency of the evoked nerve action potential.

**V. Centrifugal conduction study of the median nerve in the forearm**

A centrifugal nerve conduction study was undertaken with the same electromyograph. The active disc electrode was placed at the wrist over the median nerve and a referential distal electrode 3cm distal to the active electrode along the median nerve. The median nerve was centrifugally stimulated at the elbow with cathode distal to the anode. The stimulus consisted of a square-shaped direct electric current of 0.1msec. the distance between the recording electrode and the cathode of stimulation site was carefully measured. The recording period was set as 20msec after stimulation and recording sensitivity at 2, or 5 or 10 microvolts. An averaging technique to improve the signal-noise ratio was applied if the evoked response was too small and hard to be identified. On the oscilloscope, the latency was measured between the starting point of stimulation artifacts and the take-off point of

the evoked nerve action potential. A centrifugal nerve conduction velocity (NCV) was calculated as:
Centrofugal NCV = distance between anode and active recording electrode/latency of the evoked nerve action potential.

**VI. Conduction study of the median nerve in the forearm measured with scalp somatosensory evoked potentials**

A somatosensory evoked potential study to measure the conduction of the median nerve in the forearm was performed with a Nicolet Pathfinder machine. The pick-up scalp electrode was placed at the C3' of C4' (according to the International 10-20 system and contralateral to the stimulation side). A reference electrode was placed at the midpoint between Fz and Fpz. The recording sensitivity was set at 2, or 5 or 10 microvolts. The electric stimulation was applied to the median nerve, firstly at the wrist (distal stimulation) and at the elbow (proximal stimulation). The stimulus consisted of square-shaped direct electric currents of 0.1msec at a stimulation frequency of 3.1 Hz. An analysis period of 130msec was selected and 256 evoked responses recorded at the scalp were averaged automatically. The scalp somatosensory evoked potential (SEP) of W-shape was displayed on the oscilloscope. The first negative deflection which appeared around 17-22msec was named as the N1 peak. On the oscilloscope, the latency of each peak was measured from the starting point of stimulation artefacts. Scalp SEPs from distal and proximal stimulation were separately obtained and their latencies were separately measured. Nerve conduction velocity of the median nerve in the forearm with SEP techniques (SEP NCV) was calculated as:
SEP NCV = distance between distal and proximal stimulation / N1 latency difference between distal and proximal stimulation.

**VII. Statistical analysis**

All the neurophysiological parameters including latencies, conduction velocities and amplitudes of evoked potentials were stored in a personal computer and further analyzed with commercially available biostatistic softwar

**Results**

Table lists NCVs obtained with different electrodiagnostic techniques.

| | Normal (n=128) | ADP (n=19) | CDP (n-36) | Diabetes (n=16) |
|---|---|---|---|---|
| Motor NCV | 57.7±3.7 | 48.5± 9.7 | 30.7± 5.7 | 46.0± 3.9 |
| Sensory NCV | 61.4±4.2 | 49.6±13.2 | 38.7±10.4 | 50.6± 3.8 |
| Centripetal NCV | 63.6±3.8 | 55.9±11.1 | 37.8±15.6 | 53.5± 3.8 |
| Centrifugal NCV | 61.4±3.9 | 61.5± 9.5 | 34.4±20.0 | 53.3± 4.4 |
| SEP NCV | 64.2±6.9 | 57.4± 8.9 | 39.8±15.1 | 53.7± 13.5 |

ADP:Acute demyelinating polyneuropathy
CDP:Chronic demyelinating polyneuropathy

In acute demyelinating polyneuropathy, NCV through centrifugally recorded technique did not slow significantly as compared with that in the normal controls. NCVs from other electrodiagnostic techniques were lower than those in the normal controls.

In patients with chronic demyelinating polyneuropathy, NCV obtained from any electrodiagnostic technique was slower than the NCV with comparable technique in the normal controls. The normal controls and the patients with chronic demyelinating polyn.europathy had a same pattern of NCV difference among various electrodiagnostic techniques.

## Discussion

A peripheral nerve is composed of many nerve fibers of various diameters with different nerve conduction velocities and carrying different neural impulses. There are large myelinated fiber, small myelinated fibers and smallest unmyelinated fibers. The large myelinated fibers have a conduction velocities over 50m/s and carry proprioceptive sensation as well as motor

impulses. Involvement of large fibers in polyneuropathy would cause paresthesia, pinning and needling, sensory ataxia, hyporeflexia. Weakness and muscle atrophy can also be prominent in some patients. When the small myelinated fibers are mainly involved in polyneuropathy, loss or impairment of pinprick and temperature sensations would be the cardinal pictures. Usually, they complain of numbness, deep pain, or heat sensations in the distal limbs. When patients with polyneuropathy mainly have involvement of unmyelinated fibers, they would develop impairments of autonomic nervous system and nociception.

Polyneuropathy can pathologically be classified as primary axonal failure, myelin degeneration, a combination of both lesion, and/or anterior horn cell or neuronal disease. Instead of nerve biopsy and pathologic examination, the differential diagnosis on this aspect can be easily achieved through useful and essential information provided by a careful electrodiagnosis. Usually, when myelin degeneration is the primary target in polyneuropathy patients, they would nave obvious conduction blocks or marked slowing of peripheral nerve conduction velocities. There is only slight or moderate diminution of amplitude of the evoked response. In primary axonal failure, mild slowing of conduction velocities and marked reduction of the amplitude of evoked muscle or sensory action potentials are the distinctive electrodiagnostic feature. No conduction can be demonstrated when there is total severe axonal degeneration. Considerable delay in conduction velocites and great attenuation of the evoked responses are seen in a combination of both axonopathy and myelinopathy (8).

In routine nerve conduction velocities, the nerve fibers firstly excited by the electric currents are usually the largest fiber i. e. the large myelinated fibers. In sensory conduction study, these fibers comprise of axons conveying proprioception impulses. Function of small myelinated sensory fibers which carry superficial sensations can not be adequately evaluated with the conventional nerve conduction studies. A discrepancy between the patient's complaints and findings in sensory conduction study is not infrequently encountered in clinical practice. Nerve fibers excited in the motor nerve conduction study should be those axons arising form the anterior horn motor neurons. We suggest that nerve axons excited in different methods of nerve conduction study should be different. Different kinds of polyneuropathy would show different findings in various kind of nerve conduction studies.

In the present study, a different pattern of NCV changes were found. Nerve conductiion velocities can be evaluated with SEP technique in quite a few patinents with severe chronic demyelinating polyneuropathy. We suggest from the present study such electrodiagnostic information useful in understanding the pathophysiological mechanisms of polyneuropathy symptoms and the invasive nerve biopsy may be avoided.

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