

Measurement of Median Sensory Nerve Conduction Velocity in Koreans, Using Somatosensory Evoked Potential

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Sensory evoked potential (SEP) studies have contributed to the greater accuracy of diagnosis and evaluation in neuropathy. Normal values of SEP serve as a helpful reference in evaluating neuropathy, whether SEP or a conventional diagnostic study is employed. The conduction velocity of the median sensory nerve in 46 normal, healthy Korean individuals was determined, using SEP, and the findings compared with the findings of investigators in other countries. The mean conduction velocity was 63.15 ± 5.00 m/sec; the mean latency following stimulation at the wrist was 18.27 ± 1.35 msec, and at the elbow 14.58 ± 1.23 msec. Significant positive correlation of N_{20} latency with subject's height were found.

Key Words: Sensory nerve conduction velocity, somatosensory evoked potential.

In sensory nerve conduction measurement, it is easy to obtain sensory nerve action potentials in normal healthy persons. However, by obscuring the point of onset, stimulus artifact and dispersed potentials with low amplitude frequently obscure waveforms needed to measure sensory latencies in patients with peripheral neuropathy. Moreover, when compound motor action potentials cannot be evoked in a denervated muscle during a motor nerve conduction study, it is difficult to evaluate the status of peripheral nerves.

In a recent SEP study, by repeatedly stimulating peripheral nerves and using a signal averager it was possible for us to evaluate a whole somatosensory pathway.

Since 1973, Desmedt and others have used SEP on patients with neurological disease and in healthy persons to evaluate the conduction time of central as well as of peripheral nerves. Desmedt and Noël (1973) found that the latency of early potentials was constant. Jones (1977), Robertson and Lambert (1978) measured sensory nerve conduction velocity using constant early potential:

Since there was no published record of any

previous sensory nerve conduction velocity measurement having been done in Korea, using SEP, we, for the first time here, measured the normal latency of early potential by stimulating the median nerve and also compared our findings with those of investigators in other countries.

In evaluating peripheral neuropathy, SEP studies combined with conventional conduction studies can be used. It is thought that further continuing research will be necessary in the clinical application of SEP. SEP techniques have become an integral part of neurophysiologic assessment in the last decade.

MATERIALS AND METHODS

Subjects

Forty-six healthy Korean individuals, 30 males and 16 females, were grouped in pairs in which the members of each pair, as nearly as possible, were of the same age, and were of the same sex. Ages ranged from 19 to 60 years with the majority in the 20-29 years-of-age group (Table 1).

The mean height was 165.5 cm with a predominance of 160-169 cm in males and 150-169 cm in females (Table 2).

Methods

Measurements of sensory nerve conduction velocity were done in a quiet room maintained at a

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temperature of 24°C-26°C with the subjects in the supine position. The subjects were asked to relax and

Table 1. Age and sex distribution

Age (yrs)	Sex		Total
	Male	Female	
10 - 19	1	3	4
20 - 29	14	7	21
30 - 39	6	5	11
40 - 49	2	0	2
50 - 59	5	1	6
50 -	2	0	2
Total	30	16	46

Note: The mean age was 31.9 years.

Table 2. Sex and height distribution

height (cm)	Sex		Total
	Male	Female	
150 - 159	1	7	8
160 - 169	20	6	26
170 - 179	8	3	11
180 -	1	0	1
Total	30	16	46

Note: The mean height was 165.9 cm.

to reduce eye movements.

The frequency filter was set at 20 Hz- 2 KHz, sweep speed 5 msec/div. and sensitivity at 5 μ V/div. A square electric pulse of 0.1 msec duration was given to the median nerve at the wrist and at the elbow bilaterally. The intensity of the stimulus was controlled by observing a visible twitch of the abductor pollicis brevis, without allowing discomfort to the subject. An average of 100-150 stimuli were applied at a rate of 3/sec. An EEG needle electrode was used as the recording electrode. Recordings were made from the scalp at C₃ or C₄ (10-20 EEG electrode international system) on the contralateral side of the stimulation, referred at the medial anterior scalp just posterior to the hair line and grounded on the shoulder ipsilateral to the stimulation. Latencies were gained by stimulating the median nerve at the wrist and elbow and recording early negative potentials (N₂₀) at the scalp. Sensory nerve conduction velocity could be obtained by dividing the conduction distance by the latency difference (Δt), as follows:

$$\text{SNCV (m/sec)} = \frac{\text{CD}}{t_2 - t_1} = \frac{d \text{ (m)}}{\Delta t \text{ (sec)}}$$

SNCV : sensory nerve conduction velocity

CD : conduction distance

t_2 : N₂₀ latency of average somatosensory response recorded following stimulation of the median nerve at the wrist.

t_1 : N₂₀ latency of average somatosensory response recorded following stimulation of the median nerve at the elbow.

Analytic Method

The SNCVs of the left and right sides were compared, using the paired *t* test. In addition, the significance of correlation between the height and N₂₀ potential latency was analysed, using the regression line, the correlation coefficient, and the coefficient of determination.

RESULTS

1. The waves recorded following the stimulation of the median nerve at the wrist were of a shape very similar to those recorded following the stimulation at the elbow: 2 negative and 2 positive, fairly discrete, and W-shaped (Fig. 1,2).
2. Latency of N₂₀ Potential
The mean latency was 18.27 ± 1.35 msec (mean \pm SD), stimulating at the wrist and 14.58 ± 1.23 msec (mean \pm SD), stimulating at the elbow. There was no significant difference between the left and right sides in latencies of 18.33 ± 1.27 msec on the right and 18.20 ± 1.43 msec on the left with stimulation at the elbow and 14.66 ± 1.21 msec on the right and 14.51 ± 1.26 msec on the left with stimulation

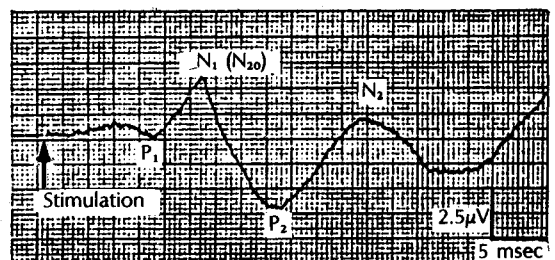


Fig. 1. Average somatosensory response showing typical quadruphasic configuration (W shape) of the initial components. The initial deflection (P₁) is positive followed by a negative wave (N₁), a second positive deflection (P₂), and a large second negative wave (N₂).

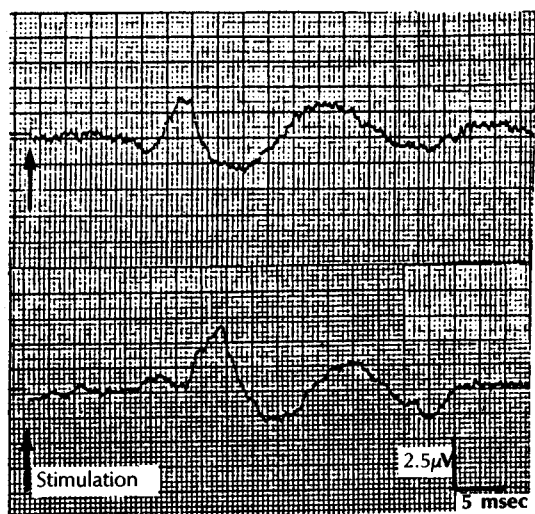


Fig. 2. Lower tracing is an average somatosensory response recorded following stimulation of the median nerve at wrist. Upper tracing shows an average response with a similar configuration, but shorter latency recorded after stimulation of the median nerve at elbow.

Table 3. N_{20} Latency of SEP

	Right Side (msec)	Left Side (msec)
WL* (Mean±S.D.)	18.33±1.27	18.20±1.43
EL† (Mean±S.D.)	14.66±1.21	14.51±1.26

WL* : N_{20} latency of average somatosensory response recorded following stimulation of the median nerve at the wrist.

EL† : N_{20} latency of average somatosensory response recorded following stimulation of the median nerve at the elbow.

Table 4. Sensory nerve conduction velocity (SNCV) of the median nerve in the forearm

	SNCV (m/sec)	
	Right Side	Left Side
Mean±SD	63.69± 5.09	62.60± 4.91
Range	55.00–75.00	55.00–71.00

Note: Total Mean±SD: 63.15±5.00 m/sec.

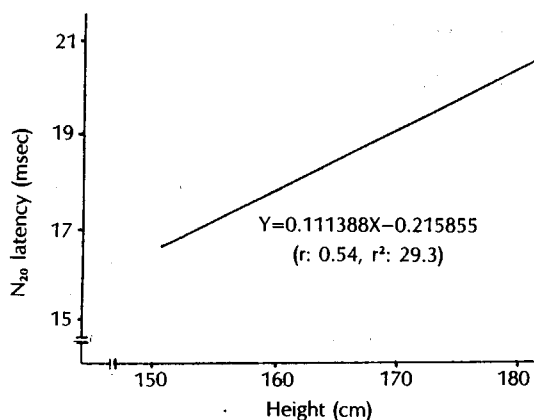


Fig. 3. Relation between height and N_{20} latency of SEP recorded following stimulation of the median nerve at wrist. Regression line is shown.

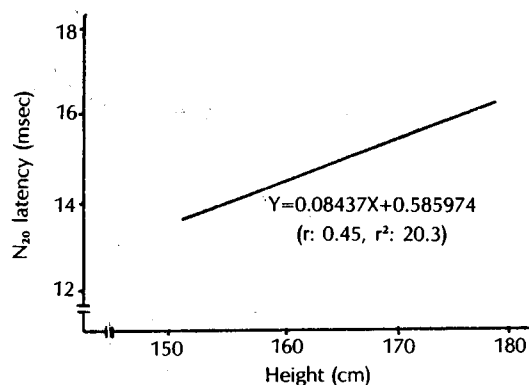


Fig. 4. Relation between height and N_{20} latency of SEP recorded following stimulation of the median nerve at elbow. Regression line is shown.

at the wrist (Table 3).

- The sensory conduction velocity of the median nerve.

The mean velocity was 63.15±5.11 m/sec (mean±SD). There was no significant difference between the mean velocity of the right sides, 63.69±5.09 m/sec, and that of the left sides, 62.60±4.91 m/sec (Table 4).

- Correlation between subject height and latency following the stimulation of the median nerve at the wrist (Fig. 3).

Correlation coefficient = 0.54

Coefficient of determination = 29.3%

- Although the greater the height, the longer the latency, height did not greatly influence latency.
5. Correlation between subject height and latency, following the stimulation of the median nerve at the elbow (Fig. 4).

Correlation coefficient = 0.45

Coefficient of determination = 20.3%

DISCUSSION

The SEP test can be a useful diagnostic aid for evaluating the whole length of the somatosensory pathway from the peripheral skin receptor to the cerebral cortex (Halliday and Wakefield 1963; Noël and Desmedt 1975). In many experimental studies it has been found that the somatosensory pathway consists of Group II afferent fibers, the dorsal column, the lemniscal sensory pathway, the cuneate nucleus in the brainstem, the thalamus, the ventroposterolateral nucleus, and the somatosensory cortex (Jones 1977).

Since Goff *et al.* (1962) and Giblin (1964) described the waveform and distribution of the SEP by stimulating the median nerve, many experts have studied the clinical significance (Desmedt 1971; Desmedt and Noël 1973), and the anatomical site responsible for each potential (Cracco 1972; Cracco and Cracco 1976; Allison *et al.* 1980; Desmedt and Brunko 1980), and standardized a description of each potential (Anziska and Roger 1981; Desmedt and Cheron 1980, 1981).

Anziska *et al.* (1978), Hume *et al.* (1979), and Jones *et al.* (1980) concluded that whether latency of early SEP potential in patients with nerve diseases is prolonged could be determined by stimulating the median nerve. Since then, the SEP study has become a popular electrodiagnostic test in evaluating diseases of the nervous system (Iragui-Madoz and Wiederholt 1977; Anziska and Cracco 1980; Desmedt and Cheron 1980).

Peripheral sensory and motor conduction velocity measurements provide objective data in peripheral neuropathy (Goodgold and Eberstein 1972; Wagner and Buchthal 1972; Burke *et al.* 1974). Because many peripheral nerve diseases involve sensory fibers first, and patients complain of sensory symptoms at each stage, Schuchmann and Braddom believed that the development of an objective and accurate, dependable sensory nerve conduction test was needed. Also, for the reason that in using a conventional nerve conduction study, sensory nerve evoked potential of an amplitude of less than 20 μ V can't be clearly obtained due to the interference of the intrinsic noise of the amplifier, it was definitely believed that the new

technique (sensory nerve conduction study) was needed. Since many electrodiagnosticians, including Anziska *et al.* (1978), have started measuring sensory nerve conduction velocity, using SEP in peripheral neuropathy, great progress has been made in accurate diagnosis and evaluation. Moreover, with the development of the averager, repetitive stimulation can be applied, and sensory nerve action potential can be averaged and recorded even in severe, far advanced peripheral neuropathy (Starr 1978) when action potential can't be recorded due to complete denervation. With the use of the SEP study, it is also now possible to differentiate between complete denervation and complete peripheral nerve injury (axonal degeneration).

If the stimulation intensity is too high, the patient feels pain and it increases the incidence of artifact because of muscular contraction. Cracco and Cracco (1976) used a degree of intensity causing a visible slight contraction of the thumb on median nerve stimulation, and Jones (1977) used a degree of intensity 3-5 times the sensory threshold. Mark and Steiner (1958) reported that intensity of stimulus has no correlation with amplitude of evoked potential recorded at the scalp. However, Lesser in 1979 reported that a very high degree of intensity of stimulus decreases the amplitude, and a high amplitude of evoked potential can be obtained using a stimulation intensity of summation of motor and sensory threshold without discomfort to the patient. Generally speaking, sensory nerves with a low threshold excite more easily than motor nerve fibers. Therefore, if muscular contraction occurs, it means that large myelinated sensory fibers are activated (Donchin *et al.* 1977).

We used a high enough degree of stimulation intensity to cause a just visible contraction of the thumb without discomfort to the subject.

Recording SEP with surface electrodes takes more time, and when the electrode is not attached to the scalp firmly, waves can become distorted. Recording, using needle electrodes, has several advantages such as less time consumption, lower intensity of stimulus needed, and less incidence of shock artifact, although one has to sterilize the needle (Wiederholt 1980). As we have indicated above, we used a needle electrode as the recording electrode.

The longer potential appearing after 25 msec is easily recorded because of its large amplitude, but it is difficult to define the normal limit due to its variability, and the fact that its anatomical responsible site is not well known. However, shorter latency potentials of less than 25 msec are measured in many laboratories since they are more stabilized, although

they have lower amplitudes (Jones 1977; Cracco *et al.* 1979; Anziska and Roger 1981). Hume and Cant (1978) measured the latency of the early potential and defined potential with fixed latency to apply to clinical evaluation. Their study proved that N₂₀ potentials evoked by stimulating peripheral nerves of the upper extremity have fixed latencies and the study can be reproduced. The anatomical responsible site for N₂₀ potential is still controversial. It is generally believed that the somatosensory cortex is the responsible site (Hume and Cant 1978; Allison *et al.* 1980). However, Chiappa *et al.* (1979, 1980) reported that the thalamocortical radiation is a responsible site.

There are many studies related to the average latency of N₂₀ potential in normal subjects. The average latency of N₂₀ potential, when stimulating the median nerve at the wrist was 19.4 ± 1.1 msec (mean \pm SD), according to Hume and Cant (1978). In an SEP investigation by Jones (1977) involving 33 normal subjects it was found that the average latency when stimulating the median nerve at the wrist was 18.3 msec and at the elbow, 15.1 msec.

The average of the latencies of the N₂₀ potentials in our study was 18.27 msec when the stimulation was done at the wrist and 14.58 msec when the stimulation was done at the elbow, findings similar to those of Jones (1977).

The average conduction velocity of the forearm segment of the median nerve as found in our study was 63.15 m/sec, another value similar to that of Jones (1977), which was 65-75 m/sec and to that of Robertson and Lambert (1978) which was 60-71 m/sec.

There are many studies on the correlation between the latency of the SEP and the height of the subject (Dorfman 1977; Hume and Cant 1978; Desmedt and Brunko 1980). According to Hume and Cant (1978), the correlation coefficient between the subject's height and the latency of the N₂₀ potential showed a high value of 0.80. In our study we found correlation coefficient values of 0.54 on wrist stimulation and 0.45 on elbow stimulation, values which were lower than those of Hume and Cant (1978). However, there is a definite correlation, since the taller the subject, the longer the latency. Since the distribution is dispersed from the main line, the height of the subject may influence the latency of N₂₀ potential, but only slightly.

A sensory nerve conduction study using SEP can evaluate the whole length of the somatosensory pathway, not only from the distal, but also from the proximal part of a peripheral nerve to its central somatosensory cortex and may constitute a diagnostic aid in brachial plexus injury (Desmedt and Nöel 1973; Jones 1979; Siivola *et al.* 1979; Glover *et al.* 1981; Chodorff *et al.* 1985), multiple sclerosis (Namerow

1968; Eisen *et al.* 1979), and Friedreich's ataxia (Nöel and Desmedt 1976; Jones *et al.* 1980), as well as in lesions between the dorsal column and the cerebral cortex (Larson and Sances 1968; Williamson *et al.* 1979; Nöel and Desmedt 1980).

CONCLUSION

SEP studies have contributed to measure of conduction velocity of sensory nerve. This was a simple, reproducible, objective and accurate method. In addition, the subjects tolerate the procedure without discomfort. We obtained normal ranges of N₂₀ potential latency and conduction velocity of median nerve in forearm segment.

The mean conduction velocity was 63.15 ± 5.00 m/sec, the mean latency of N₂₀ potentials following stimulation at wrist was 18.27 ± 1.35 msec and at the elbow 14.58 ± 1.23 msec. There is a positive correlation between latency and subject height.

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