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Abstract
In a study of the relationship between height and the **somatosensory evoked** potentials (SEPs) in 24 normal individuals, we found significant linear correlations between height and the latencies of major peaks along the pathway in the **median**, ulnar, and first, third, and fifth digital SEPs. Thus, we conclude that the measured latency should be compared with the expected latency according to the subject's height before it is interpreted as normal or abnormal.

Peak latency vs. height!

remains the same for all recording electrode sizes. These CMAPs were recorded with the disc electrodes centered over the same recording point over the muscle belly at its endplate zones, i.e. they were concentrically situated.

In practical applications, it appears that tiny variations in the electrode size from the standard 10-mm diameter circular type have negligible effects on the CMAPs when recorded from the ADM muscle, and perhaps from other muscles of comparable size and geometry. However, when recording from relatively large muscles or those with greater dispersion of the motor endplates, the 10-mm diameter electrode may not be the ideal size for study. The CMAPs may be more variable with slight changes in the electrode size under these conditions. Also, irregularities in the CMAPs may be related in part to variable pick-up of "far-field" potentials by recording electrodes of different sizes. These "far-field" potentials originate from muscles that were activated during the electrical stimulation, but are located at a distance from the recording electrodes.

References

1. EKSTEDT, J. and STÅLBERG, E.: Single fibre electromyography for the study of the microphysiology of the human muscle. In: Desmedt, J.E. (Ed.): *New Developments in Electromyography and Clinical Neurophysiology*, Vol. 1, Karger, Basel, pp. 89-112, 1973.
2. KIMURA, J.: *Electrodiagnosis in Diseases of Nerve and Muscle: Principles and Practice*, F.A. Davis, Philadelphia, 1983.

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Height, an important factor in the latency of somatosensory evoked potentials

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Abstract

In a study of the relationship between height and the somatosensory evoked potentials (SEPs) in 24 normal individuals, we found significant linear correlations between height and the latencies of major peaks along the pathway in the median, ulnar, and first, third, and fifth digital SEPs. Thus, we conclude that the measured latency should be compared with the expected latency according to the subject's height before it is interpreted as normal or abnormal.

Key-words: Evoked potentials — height — digital nerves — median nerve — ulnar nerve.

Introduction

In somatosensory evoked potential (SEP) studies, prolonged latency is often used as one of the indices of abnormality. The distance between the stimulating and recording electrodes is not usually considered to be an important factor in the SEP latency measurement. However, it is well-known that the latency is related to the distance between the stimulating and recording electrodes and, therefore, in the nerve conduction study of peripheral nerves the nerve conduction velocity is regarded as a better index of abnormality than the latency. We studied the relationship between height and the SEPs evoked by median, ulnar, and first, third, and fifth digital nerve stimulation.

Materials and method

Twenty-four normal healthy volunteers, 17-40 years of age (10 men and 14 women), were studied. We selected this age range to avoid any influence of age on the latency. The range of height was 155-185 cm (mean: 168.6 cm). The subjects were tested in a supine position, resting comfortably in a quiet room, and were allowed to sleep during recording. In some individuals two sides were tested. Thirthy-eight nerves for both median and ulnar and 36 nerves for each of the first, third, and fifth digital SEPs were tested. The median and ulnar nerves were stimulated at the wrist with surface electrodes for median and ulnar SEPs. The first, third, and fifth digital nerves were stimulated separately by ring electrodes on the fingers for digital SEPs. The nerves were stimulated using a stimulus of 0.1 msec duration with a rate of 5.5/sec. Stimulation intensity for median and ulnar SEPs was adjusted so that a minimal twitching of the fingers was obtained. Stimulation intensity for digital SEPs was three times the sensory threshold.

To record the SEP, ordinary EEG surface electrodes were used. The impedance of the recording electrode was kept below 5 K-ohms. Each SEP recording consisted of 750-1000 averagings for median and ulnar SEPs, and 1000-1500 averagings for digital SEPs. Each SEP recording was repeated and superimposed for

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reproducibility of potentials. Amplifier bandpass was 10-2000 Hz. The Erb's potentials (N9) were recorded with an active electrode at the supraclavicular fossa and a reference electrode at the ipsilateral mastoid process. The cervical potentials (N13) were recorded with an active electrode at the fifth cervical spine and a reference electrode at the mid-forehead (FPz). The cortical potentials (P13 and N20) were recorded with an active electrode at the somatosensory area (2 cm behind C3 or C4) and a reference electrode at the mastoid process contralateral to the stimulation. To eliminate the chance of errors caused by possible prolongation of latencies due to peripheral nerve lesions, the following tests were performed: the motor and sensory nerve conduction and the distal F-response tests in the median and ulnar nerves. All these tests were normal in all individuals. Skin temperature was maintained above 32 degrees C in the forearm.

Results

In all SEPs a highly significant correlation ($P<0.001$) was noted between height and the latencies of major peaks along their pathways: the N9 at the Erb's point, the N13 in the cervical SEP, and the P13 and N20 in the cortical SEP (Table 1, Fig. 1, 2, 3, 4, 5). The N9-N13 interpeak latency was significantly correlated with height in the ulnar ($P<0.001$) and the median ($P<0.01$), but poorly correlated in any digital SEP ($P>0.01$). The N13-N20 interpeak latency was not correlated with height in any SEP. These findings indicate that central conduction time, especially in the N13-N20 segment, is not correlated with height, and that the peripheral nerve conduction to N9 latency is mainly responsible for the latency-height relationship.

Table 1. — *Correlation coefficients between height and latencies of the various peaks of the median, ulnar, and digital SEPs*

Peak latency	Median	Ulnar	1st digit	3rd digit	5th digit
N9	0.672**	0.775**	0.572**	0.536**	0.693**
N13	0.760**	0.789**	0.676**	0.714**	0.747**
P13	0.644**	0.881**	0.701**	0.558**	0.646**
N20	0.696**	0.808**	0.651**	0.666**	0.703**
N9-N13 interpeak	0.438*	0.575**	0.358	0.305	0.316
N13-N20 interpeak	0.312	0.351	0.243	0.339	0.209

* $P<0.01$
** $P<0.001$

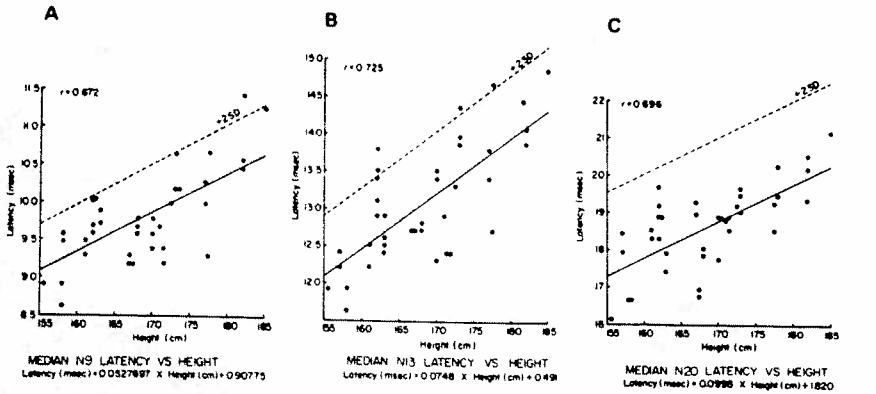

Fig. 1. — Relationship between height and the latencies of the various peaks of the median SEPs: A, at Erb's point; B, at C5 spine; C, at C3' or C4'. Solid line represents mean value. r = correlation coefficient.

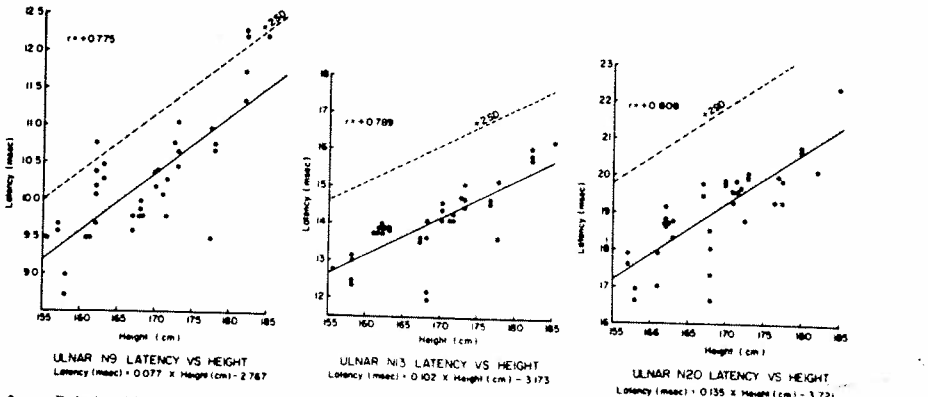

Fig. 2. — Relationship between height and the latencies of the various peaks of the ulnar SEP. See Fig. 1 for other details.

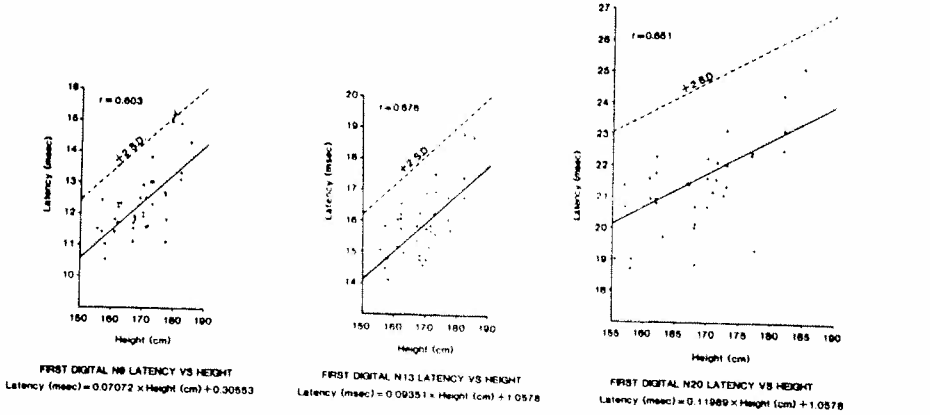

Fig. 3. — Relationship between height and the latencies of the various peaks of the first digital SEPs. See Fig. 1 for other details.

Discussion

It is well-known that the SEP morphology differs according to the montage employed (2, 16). We used a technique of near-field evoked potential studies showing most consistently N9 on the Erb's point, N13 on the C5 cervical spine, and P13-N20 on the contralateral parietal cortex.

There is no question that the N9 potential on the Erb's point originates from the brachial plexus in SEPs stimulated by nerves of the upper extremity (22), but the anatomical origin of other potentials is still the subject of controversy. It has been suggested that the P13/N13 potential is generated from the dorsal column at the level of the high or mid-cervical cord (14, 21, 23) or at the foramen mag-

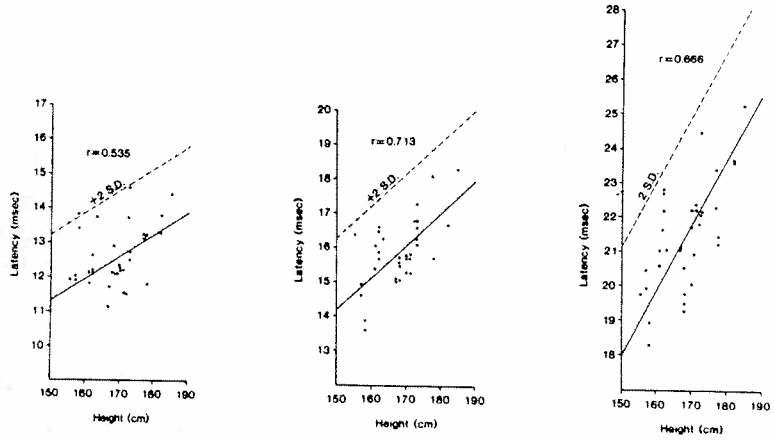

Fig. 4. — Relationship between height and the latencies of the various peaks of the third digital SEPs. See Fig. 1 for other details.

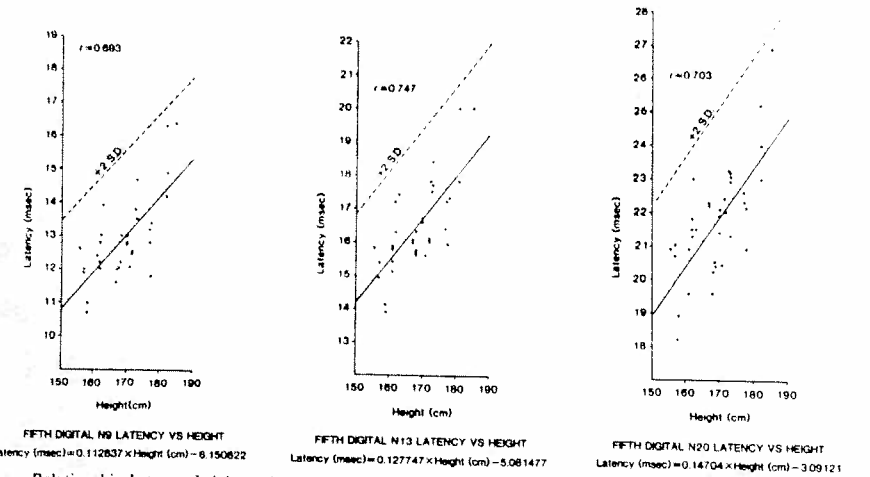

Fig. 5. — Relationship between height and the latencies of the various peaks of the fifth digital SEPs. See Fig. 1 for other details.

num (11, 16). An origin of the cuneate nucleus has also been proposed (5, 12, 13). The generator of the parietal N20 potential has been disputed and suggested to have a thalamic (2, 11), thalamocortical, or cortical origin (4, 12, 15, 21, 23). Even with these minor controversies, however, it is certain that the generators of the major potentials in our studies are located along the course of the somatosensory pathway. Thus, it is not surprising

that the latencies of major peaks along the sensory pathway are related to height and arm length. A good correlation was found between peak latencies and arm length measured from the wrist to the cervical spine (3, 12, 17, 19) or the height (1, 3, 12, 18), and also between onset latencies (7) of the cervical N13 SEP evoked by median or ulnar nerve stimulation at the wrist and arm length. Several studies also found a good correlation between the N20 latency in the median SEP and arm length (8, 12, 15, 19) or height (6, 12, 18). On the other hand, several authors (1, 4, 10, 12, 24) reported no significant correlation between the central conduction time (N13 of P14-N20 interpeak latency) and either height or arm length.

Thus, our study of the median and ulnar SEPs confirmed the findings of Allison et al. (1), Chu and Hong (3), Hume and Cant (12), Mervaala et al. (18), and Zegers de Beyl et al. (24). Furthermore, we documented a good correlation between the height and P13 latency. Recently, Synek (20) found a good correlation between arm length and major peaks, including N9, N13, and N20 latencies in the first, third, and fifth digital SEPs. We documented a good correlation between height and major peaks of the first, third, and fifth digital SEPs. We also fould that the central conduction time of the N13-N20 interpeak segment is not correlated with the height in the digital SEPs.

There have been a few reports that the N9-N13 interpeak latency is not correlated with body size (4, 10), but our study showed that the N9-N13 interpeak latency was correlated with height in the median and ulnar SEPs but not in the digital SEPs. We thought that this poor correlation in digital SEPs was due to the technical problem of low amplitudes and the absence of clearly definable peaks in some digital nerve-stimulated SEPs, as Desmedt and Cheron (4) and El-Negamy and Sedgwick (9) have already pointed out. The poor correlation between the N13-N20 interpeak latency and the height was not unexpected because, in the supplementary data of this study, the distance between C5 and cortex measured by an obstretic caliper showed poor correlation to the height ($r = 0.437$).

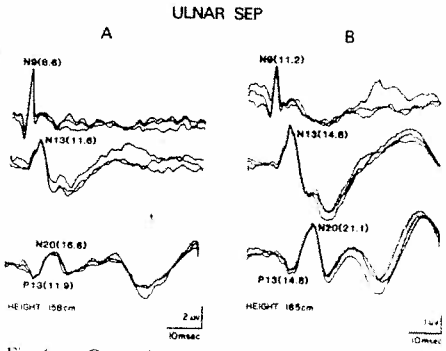

Fig. 6. — Comparison of the latencies in the ulnar SEPs between short (A) and tall (B) individuals.

Comparing the latency with height in the F-wave response has been a traditional means of evaluating the proximal segment of a peripheral nerve. Our study clearly showed that a similar comparison is essential in SEP latency measurement using a linear regression line. The measured latencies of the various major peaks of the SEP should be compared with the expected norm according to the subject's height. When the measured latency is outside the normal limit (mean + 2 SD) of the expected value, then it should be considered a reliable indicator of abnormality. This is more accurate than the conventional method of blind latency analysis. Normal latencies in tall individuals may be interpreted as abnormal for short individuals if the latencies are not adjusted for height (Fig. 6). On the other hand, the central conduction time (N13-N20) is not affected by height in any SEPs. Thus, the N13-N20 interpeak latency can be used as an index of conduction measurement without any adjustment for height.

References

1. Allison, T., Wood, C.C. and Goff, W.R.: Brain stem auditory, pattern-reversal visual, and short-latency somatosensory evoked potentials: latencies in relation to age, sex, and brain and body size. *Electroencephalogr. Clin. Neurophysiol.*, 55: 619-636, 1983.

interpeak lat. do not Δ with height! N13-N20

2. CHIAPPA, K.H.: *Evoked Potentials in Clinical Medicine*, pp. 208-214, 296-308, Raven Press, New York, 1983.
3. CHU, N. and HONG, C.: Erb's and cervical somatosensory evoked potentials correlations with body size. *Electroencephalogr. Clin. Neurophysiol.*, 62: 319-322, 1985.
4. DESMEDT, J.E. and CHERON, G.: Central somatosensory conduction in man: Neural generators and interpeak latencies of far field components recorded from neck and right or left scalp and ear lobes. *Electroencephalogr. Clin. Neurophysiol.*, 50: 382-403, 1980.
5. DESMEDT, J.E. and CHERON, G.: Prevertebral (esophageal) recording of subcortical somatosensory evoked potentials in man: the spinal P13 component and the dual nature of the spinal generators. *Electroencephalogr. Clin. Neurophysiol.*, 52: 257-275, 1981.
6. DORFMAN, L.T. and BOSLEY, T.M.: Age related changes in peripheral and central nerve conduction in man. *Neurology*, 29: 38-44, 1979.
7. EISEN, A. and NUDEMAN, K.: F-wave and cervical somatosensory response conduction from the seventh cervical spinous process to cortex in multiple sclerosis. *Canad. J. Neurol. Sci.*, 5: 289-295, 1978.
8. EISEN, A. and ODUSOTE, K.: Central and peripheral conduction times in multiple sclerosis. *Electroencephalogr. Clin. Neurophysiol.*, 48: 253-265, 1980.
9. EL-NEGAMY, E. and SEDGWICK, M.: Properties of a spinal somatosensory evoked potential recorded in man. *J. Neurosurg. Psychiatry*, 41: 762-768, 1978.
10. GANES, T.: A study of peripheral, cervical and cortical evoked potentials and afferent conduction times in the somatosensory pathway. *Electroencephalogr. Clin. Neurophysiol.*, 49: 446-451, 1980.
11. GOLDIE, W.D., CHIAPI, K.H. and YOUNG, R.R.: Brainstem auditory and short latency somatosensory evoked responses in brain death. *Neurology*, 31: 248-256, 1981.
12. HUME, A.L. and CANT, B.R.: Conduction time in central somatosensory pathways in man. *Electroencephalogr. Clin. Neurophysiol.*, 45: 361-375, 1978.
13. JONES, S.J.: Short latency potentials recorded from the neck and scalp following median nerve stimulation in man. *Electroencephalogr. Clin. Neurophysiol.*, 43: 853-863, 1977.
14. KAJI, R. and SUMNER, A.J.: Bipolar recording of short somatosensory evoked potentials after median nerve stimulation. *Neurology*, 37: 410-418, 1987.
15. KRITCHEVSKY, M. and WIEDERHOLT, W.C.: Short-latency somatosensory evoked potentials. *Arch. Neurol.*, 35: 706-711, 1978.
16. LUEDERS, H., LESSER, R., HAHN, J., LITTLE, J. and KLEM, G.: Subcortical somatosensory evoked potentials to median nerve stimulation. *Brain*, 106: 341-372, 1983.
17. MATTHEWS, W.B., BEAUCHAMP, M. and SMALL, D.G.: Cervical somatosensory evoked responses in man. *Nature* (Lond.), 252: 230-232, 1974.
18. MERVAALA, E., PAAKKONEN, A. and PARTANEN, J.V.: The influence of height, age and gender on the interpretation of median nerve SEPs. *Electroencephalogr. Clin. Neurophysiol.*, 71: 109-113, 1988.
19. SMALL, D.G., MATTHEWS, W.B. and SMALL, M.: The cervical somatosensory evoked potentials (SEP) in the diagnosis of multiple sclerosis. *J. Neurol. Sci.*, 35: 211-224, 1978.
20. SYNEK, V.M.: Somatosensory evoked potentials after stimulation of digital nerves in upper limbs: normative data. *Electroencephalogr. Clin. Neurophysiol.*, 65: 460-463, 1986.
21. TSUJI, S., SHIBASAKI, H., KATO, M., KUROIWA, Y. and SHIMA, F.: Subcortical, thalamic and cortical somatosensory evoked potentials to median nerve stimulation. *Electroencephalogr. Clin. Neurophysiol.*, 59: 465-476, 1984.
22. YAMADA, T.: The anatomic and physiologic basis of median nerve somatosensory evoked potentials. *Neurologic Clinics*, 6: 705-733, 1988.
23. YAMADA, T., KIMURA, J., WILKINSON, T. and KAYAMORI, R.: Short- and long-latency median somatosensory evoked potentials: findings in patients with localized neurological lesions. *Arch. Neurol.*, 40: 215-220, 1983.
24. ZEGERS DE BEYL, D., DELBERGHE, X., HERBAUT, A.G. and BRUNKO, E.: The somatosensory central conduction time: physiological considerations and normative data. *Electroencephalogr. Clin. Neurophysiol.*, 71: 17-26, 1988.

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Segmental hypermobility in lumbar spine and entrapment of dorsal rami

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Abstract

Low back pain patients (N = 18) having segmental hypermobility in one lumbar segment and healthy controls (N = 13) were chosen for this study. Patients had no other structural spinal pathology except displacement of one vertebra to another in lateral X-ray bending pictures. Kinetic intramuscular EMG-activity from paraspinal muscles was studied off-line during back flexion and reextension. Routine needle EMG study of paraspinal muscles was also performed in addition to measurements of the tibial nerve H-reflexes and peroneal F-responses. Results showed that the number of MUAPs in erector spinae muscle on voluntary efforts was rarefied at hypermobile levels, and spontaneous activity, positive sharp waves and high frequency discharges were found in more than half of the patients in paraspinal muscles, usually at hypermobile levels only. No signs of proximal nerve root compression were found. This indicates neuropathy of dorsal rami at the instable level.

Key-words: Low back pain – EMG – motor unit – neuropathy.

Introduction

It has been shown that such low back pain patients who had no evidence of rooth compression syndrome and were not submitted to myelography, tended to show denervation activity in paraspinal muscles only (5). Investigators noted that bony changes in the lumbar region correlated with the degree of denervation activity in paraspinal muscles (5). Because of intimate anatomical relationship, it is obvious that degenerative changes involving apophyseal joints can cause irritation of dorsal rami, especially to the medial branch (17). For this reason, needle EMG examination of the paraspinal muscles has a potential value of documenting injury of the posterior rami. We have found high-amplitude, long-duration potentials in kinetic EMG of paraspinal muscles of segmentally instable patients and these can be caused by synchronation or hypertrophy of motor units (16). In this study kinetic measurements were chosen because assessment of EMG-pattern (vs. absolute level) may be the best way to show the biomechanical events taking place in the lumbar region (8, 19) and because lumbar hypermobility is a controversial and poorly understood biomechanical and functional problem (15). In healthy persons, previous investigations have shown that during symmetrical movements of the trunk in the sagittal plane, there is no difference in paraspinal kinetic EMG-activity at various segments (18). The aim of this study was to investigate kinetic EMG-activity of the paraspinal muscles of segmental hypermobility patients and healthy controls, to compare activities at hypermobile and normal level and to perform routine needle EMG in these patients.

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