Motor Nerve Conduction Velocity Studies of the Ulnar Nerve in Patients with Leprosy[1, 2]

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Many of the disabling features of leprosy are caused by peripheral nerve impairment involving both sensory and motor modalities. Pathologic changes in an affected nerve are usually seen at a site where the nerve passes over a bone or joint, or where the nerve is superficial. In the arm the most commonly involved nerves, in order of frequency, are the ulnar at the elbow and the median at the wrist. In the leg they are the posterior tibial at the ankle and the common peroneal at the knee. The ulnar nerve becomes involved most often at the elbow just proximal to the ulnar groove and, less frequently, at the wrist (1).

Motor nerve conduction velocity studies have become recognized, in the past five or six years, as important aids in assessing peripheral nerve dysfunction. To date, many studies have been made relative to a wide variety of neuropathies. There have not been any systematic studies, however, concerning motor nerve conduction in patients with leprosy. Magora *et al.* (7) noted that they have been evaluating conduction times, but did not have sufficient data to report.

As part of a larger study of the rehabilitation of persons with leprosy, the present study was conceived to find methods for detecting peripheral nerve involvement sufficiently early to prevent disability by early treatment. In addition, a simple method is needed to assess the response of the nerves involved to varied therapeutic regimens.

As leprosy affects the nerves in specific areas, a method incorporating segmental evaluation of the nerve is needed. It is the purpose of this paper to present segmental nerve conduction velocities of the ulnar nerve in normal subjects and in patients with leprosy.

MATERIALS AND METHODS

Ulnar nerve motor conduction velocities were recorded on 38 ulnar nerves in 21 control subjects. These persons have had no neurologic illnesses, either at the time of examination or in the past. Forty-two subjects, with proven leprosy, who were patients at the U.S. Public Health Service Hospital, Carville, Louisiana, were investigated in a similar manner. The two groups were chosen essentially within the same age distribution (20-45 years) in order to negate any effects of aging on nerve conduction.

The ulnar nerve was stimulated at five points along its course from the axilla to the hand (Fig. 1). Point one (1) was in the axilla, point two (2) was at the midhumerus level, point three (3) was 3 cm. above the ulnar groove, point four (4) was 3 cm. below the ulnar groove, and the last point (5) was at the wrist. Supramaximal stimuli were used in all tests.

A single channel Teca Model 1.2-7 electromyograph was used in the investigations. The stimulator used produced a square wave of variable duration up to 1 msec. Voltages could go as high as 300 volts, although this was rarely needed except in severely involved nerves.

Surface electrodes were placed over the abductor digiti quinti muscle and the

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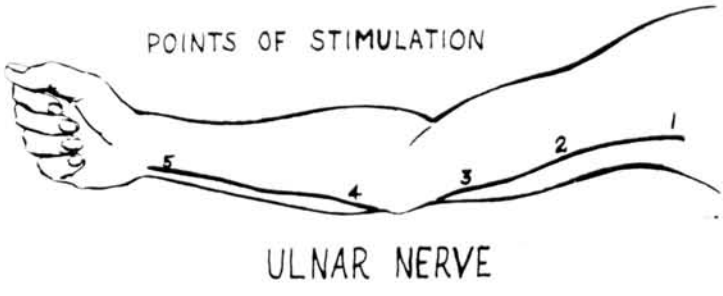

FIG. 1. Sites of stimulation of the ulnar nerve.

ground electrode was located over the extensor surface of the distal third of the forearm.

The stimulus was displayed on a cathode-ray tube. The stimulus triggers a single sweep, and the latency of the response is measured at the point where the motor response first leaves the baseline. Times are calculated automatically by a timer built into the machine, but were also confirmed by polaroid photos of the responses.

Testing was done under similar environmental conditions in order to minimize any extraneous variables. Repeated examinations of the same persons by various examiners gave similar data.

RESULTS

Studies on normal controls show a definite decrease in conduction velocity at the elbow (Table 1), with a mean conduction time of 53.3 m/sec, the standard deviation being 5.6 m/sec. Most of the values fell within a very narrow range, but there were several nerves in which times were exceptionally fast or, conversely, very slow. The two controls with rapid conduction times at the elbow had faster times at the elbow than at any other segment. This contrasts with all of the other normals, in which it was the slowest conducting segment. The three persons with velocities lower than 45 m/sec were closely questioned, and there was definitely no history of ulnar nerve symptomatolgy.

The proximal segments of the nerve conduct impulses at a more rapid rate than the distal segments (Table 1). After the slowing at the elbow, the conduction velocity increases in the forearm. Distal latencies in this study are comparable with published figures ([3, 9]).

Patients with leprosy were divided initially into two groups: (a) those with no clinical evidence of abnormality, either objective or subjective, in the ulnar nerve, and (b) those with definite ulnar nerve disease. Patients with no signs of disease in the nerve were subdivided further into those with normal motor conduction velocities and those with slowed conduction velocities at the elbows. Patients with evidence of peripheral nerve involvement were divided into those who could be stimulated and those who could not be stimulated. Some patients demonstrated unilateral involvement, thus accounting for an uneven number of nerves tested. Calculations were made from nerves tested rather than by number of patients tested.

Findings in the patients are seen in Table 1. Some patients who were normal clinically demonstrated conduction times across the elbow very similar to findings in the control group. The minimal tendency to slower conduction, as noted in Table 1, possibly reflects some environmental or medication factor seen in patients and not in the control group. Other patients who demonstrated abnormal conduction at the elbow, but with normal clinical findings, tended also to have slower conduction above and below this area. Figure 2 compares ranges and mean conduction velocities of the various segments in normal subjects and in patients.

Patients with ulnar nerve deficit clinically and abnormal conduction at the elbow generally demonstrated slowing in other segments of the nerve and prolonged latencies. This latter change might signify inflammatory invasion of the nerve at the wrist. There were three clinically abnormal patients with normal motor velocities. One

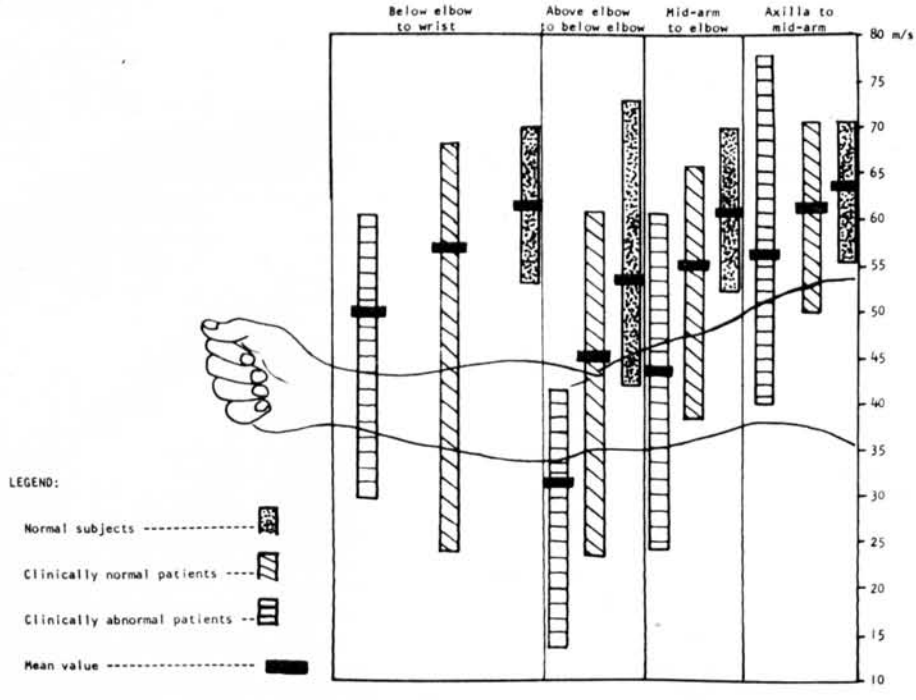

FIG. 2. Motor nerve conduction velocity ranges and mean values in normal subjects and patients with leprosy. Note that in each group conduction across the elbow is slower than in proximal or distal segments. Also the clinically normal patients show a wide range in conduction across the elbow with 41 per cent demonstrating abnormally slow conduction in this segment.

of these had only sympathetic dysfunction, as evidenced by sweat testing, and the other two had only minimal sensory loss. There were other patients, however, with clinical findings limited to the sensory system who showed slowing of motor conduction.

DISCUSSION

The finding of reduced conduction at the elbow in our normal controls has been described by other investigators [2]. Jebsen [5], using similar technic in a systematic study on segmental evaluation of the ulnar nerve, described a mean conduction and range of findings essentially the same. Decreased temperature due to superficial position of the nerve and a vulnerability to numerous minor traumatic insults, are factors that might affect conduction in this segment. The standard deviation for slowing at the elbow in the normals was 5.6 m/sec. Two standard deviations below the mean would be 43.1 m/sec. Most velocities below this level should be considered abnormal.

With the exception of the elbow region, the proximal segments conduct at a faster rate than distal ones, a finding reflected in the experience of others [8, 9, 10]. Jebsen also points out the increase in velocity in the forearm after the slowing in the elbow [5].

The sites of stimulation were arbitrary, but were chosen because of accessibility of the underlying nerve. At the midhumeral level the nerve is deep and care has to be exercised to press the stimulator directly at right angles to the arm. This should be done because the overlying soft tissue can be moved up to 1.5 cm. proximally or distally, causing possible variation in the point of stimulation and the point of measurement. Trojaborg noted similar difficulties in evaluating both ulnar and median nerves [10].

In patients with muscle atrophy, surface pick-up electrodes are frequently not ade-

TABLE 1. *Motor conduction velocities of ulnar nerve segments in normal subjects and patients with leprosy.*

	Normal subjects	Patients		
Segment	38 nerves Control	27 nerves Normal exam. Normal NCT[a]	21 nerves Normal exam. Abnormal times	32 nerves Abnormal exam. Abnormal t me
Axilla to midhumerus	Mean 63.9 Range 70.7–55.5	61.9 70.6–52.7	61.1 71.0–50.0	56.2 78.0–40.0
Midhumerus to above elbow	Mean 61.8 Range 70.0–52.2	56.4 66.0–41.1	53.1 65.7–38.5	43.6 60.7–24.2
Above elbow to below elbow	Mean 53.3[b] Range 73.0–42.0	51.3 61.0–43.2	36.6 43.8–23.8	31.6 41.3–13.6
Below elbow to wrist	Mean 61.6 Range 70.0–53.3	59.5 68.3–52.6	55.4 65.4–24.1	50.1 60.5–29.9
Distal Latency	Mean 2.55 Range 3.2–2.1	2.74 4.0–2.0	2.92 3.9–2.0	3.3 8.8–2.0

[a] NCT = nerve conduction time.
[b] Standard deviation = 5.6 m/sec.

quate and needle electrodes are required to produce a measurable potential. In some instances the first dorsal interosseous muscle provides a more reliable pick-up point, even in the presence of an apparently adequate abductor digiti quinti.

There was considerable difficulty in stimulating the nerve above and below the elbow in patients who had had transposition of the nerve to the antecubital area. In this procedure the nerve is usually buried beneath muscle and the course of the nerve is quite variable. Studies are in progress to improve the technic of evaluating these nerves, as some method is needed to monitor the efficacy of this mode of therapy.

Interest has become centered on patients with known leprosy and a normal neurologic evaluation of the ulnar nerve, but with abnormally slow conduction at the elbow. This change may be an early sign of ulnar nerve involvement, thus being of some prognostic value. With this finding therapy can be directed to the nerve prior to the time when the patient becomes disabled, and serial evaluations could monitor the progress of the disease and the effect of the treatment. It could be used also to help evaluate and compare the various methods of treatment.

One problem encountered was determination of the exact point where the initial motor response began on the visual display. In the more severely involved patients, motor conduction times were nearly normal, but the response was spread out over a longer time, and was of lower voltage. This finding is due to slowing in some of the fibers with temporal dispersion of the times the impulses arrive at the muscle to evoke a motor response. Placement of the recording electrode over the motor point of the muscle gives the sharpest endpoint on the cathode-ray tube display.

The use of nerve action potentials to evaluate the nerve is presently being studied. The sensory fibers often are more sensitive to nerve damage than motor fibers, and action potentials, and their conduction, may be altered prior to motor changes (4). There were three persons with normal motor conduction; yet they

were clinically abnormal, mostly in the sensory modalities. It is more likely that nerve action potential studies would give pertinent data in these patients.

The recent technic of threshold stimulation, described by Juul-Jensen and Mayer ([6]), may be another approach to evaluating the peripheral nerve. Studies using this approach to nerve conduction are under way in our facilities also.

Extension of this study to other nerves is contemplated. With knowledge of the pathology of the disease in each nerve, a protocol for segmental study of the nerve can be set up to evaluate the early changes that occur prior to the onset of clinical dysfunction.

SUMMARY

A technic of segmental evaluation of the ulnar nerve conduction velocities in normal and abnormal subjects is described. The conduction is normally reduced at the elbow and in normal subjects averages 53.3 m/sec. This finding is similar to previously reported data.

This method was used to evaluate patients with known leprosy; it showed a significant drop in conduction at the elbow in persons whose nerve was clinically involved. In addition, some patients not clinically involved, showed reduction in their conduction velocities. It is felt that this latter group may represent the preclinical stage of a neuropathy.

Serial evaluation of motor nerve conduction times will aid in early detection, treatment, and clinical assessment in the neuropathy of leprosy.

RESUMEN

Se describe una técnica para evaluar la velocidad de conducción de segmentos del nervio ulnar en personas normales y anormales. La conducción normalmente se reduce a nivel del codo y en personas normales tiene un promedio de 53.3 m/seg. Este hallazgo es similar a la información previamente comunicada.

Este método se usó para evaluar pacientes con lepra reconocida; mostró una reducción significativa de la conducción en el codo en personas cuyo nervio estaba clinicamente comprometido. Además en algunos pacientes que no estaban clinicamente comprometidos, mostró una reducción en la velocidad de conducción. Se estima que este último grupo puede representar una etapa preclínica de una neuropatía.

La evaluación seriada del tiempo de conducción de los nervios motores ayudará en el diagnóstico temprano, tratamiento y evaluación clínica de la neuropatía de la lepra.

RÉSUMÉ

On décrit ici une technique d'évaluation segmentaire des vitesses de conduction du nerf cubital, chez des individus normaux et anormaux. La conduction est normalement réduite au niveau du coude, et chez des sujets normaux elle atteint la vitesse de 53.3 m par seconde en moyenne. Cette observation est semblable à d'autres données qui ont été antérieurement rapportées.

La méthode a été utilisée pour procéder à des évaluations chez des malades dont on savait qu'ils étaient atteints de lèpre. On a observé une chute significative de la conduction au niveau du coude chez des individus dont le nerf était cliniquement atteint. En outre, certains malades sans signes cliniques témoignaient d'une réduction des vitesses de conduction. On à le sentiment que ce dernier groupe peut représenter le stade pré-clinique d'une neuropathie.

L'évaluation en séries des temps de conduction du nerf moteur contribuera au dépistage précoce, au traitement, et à l'évaluation clinique de l'atteinte nerveuse dans la lèpre.

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