Motor-nerve conduction studies in young patients with diabetes mellitus

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LITTLE information is available concerning the motor-nerve conduction velocity and its possible value in the overall treatment of young diabetics. In young, energetic patients, diabetes is of relatively short duration. Clinically, these patients often are neurologically asymptomatic; therefore, it would be most helpful to have a simple objective test to determine the presence of any early functional change in the peripheral nervous system. It is well known that in the adult diabetic an abnormally low motor-nerve conduction velocity may be the first sign of imminent clinical neuropathy.

A common neurologic disorder associated with diabetes mellitus clinically affects the peripheral nerves. Sensory symptoms have been reported earliest, and frequently first appear in the lower extremities in a distal and symmetric distribution. The evaluation of subjective symptoms being somewhat unreliable, an objective test was sought for determining the extent of injury of the peripheral nerves in patients with diabetes mellitus. Nerve conduction velocities, of both motor and sensory nerves as related to the diabetic population have been reported.[1-6] Most of these nerve-conduction tests were done on adult diabetics, in whom significant decreases in the motor-nerve conduction velocities were found.

Many young diabetic patients are examined regularly at this institution, thus offering us an excellent opportunity to study the motor-nerve conduction velocities in a young age group. This report presents the data of our study.

Selection of Patients and Method of Study

Determinations of motor-nerve conduction velocities in the median and the peroneal nerves were made in 20 young diabetic patients (12 females and 8 males)—outpatients or patients in the Cleveland Clinic Hospital. Their ages ranged from 5 to 23 years, with an average of 14 years. At the time diabetes mellitus was diagnosed the patient's ages ranged from 2 to 18 years. The known duration of diabetes extended from that diabetes newly diagnosed (three patients) to 21 years; the average duration was six years. No

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attempt was made to correlate the motor-nerve conduction velocities with sex, age, or duration of diabetes.

Upon direct questioning, eight of the 20 patients had a history of paresthesia, such as occasional tingling or burning sensations of the feet or hands. Patients known to have a concomitant disease affecting the peripheral nervous system were excluded from the study. When previous trauma or infection was known to have occurred in an extremity, the velocity of motor-nerve conduction was determined on the opposite side.

The procedure for determining the velocity of conduction of the peroneal nerve was as follows. Supramaximal stimulation of the peroneal nerve by bipolar surface electrodes was performed at the knee and at the ankle. Silver electrodes (8-mm diameter) were placed on the skin over the belly of the musculus extensor digitorum brevis and near the base of the fifth toe. The stimulus artifact and the muscle action potential were displayed on an oscilloscopic screen. A calibrated sweep speed provided the time base. A photograph was taken of this muscle action on the oscilloscopic screen when both the distal and proximal points were stimulated. The time required for the stimulus to travel between the two points of stimulation was determined by inspection of the photograph. Surface distance between the two corresponding points of stimulation was measured. The motor-nerve conduction velocity was calculated in meters per second.

The median-nerve conduction velocity was determined in a similar manner after stimulation at the elbow and at the wrist. In addition, the latency delay at the wrist was recorded.

In each of eight patients the intramuscular temperature was recorded of the anterior tibial muscle at a point corresponding to the midposition of the peroneal nerve.

RESULTS

Motor-nerve conduction velocities. The conduction velocities for both the median and the peroneal nerves in all the patients are graphed in *Figures 1 and 2,* respectively. A mean value of 41 m per second (range of 25 to 54 m) was obtained for the peroneal nerve. Data on the median-nerve conduction velocity revealed a mean value of 49.5 m per second with a range of 36 to 64 m per second.

The mean value with the standard error of the mean for each of the two nerves studied in the young diabetic patients was compared to normal values with their standard error of the mean as reported in the literature[7, 10] (*Table 1*).

Peroneal nerve. Normal mean values as reported in the literature are 50 ± 0.6 m per second (reference 7), and 49.5 ± 1 m per second (reference 4). Our mean differed from those reported for normal persons by 8 m per

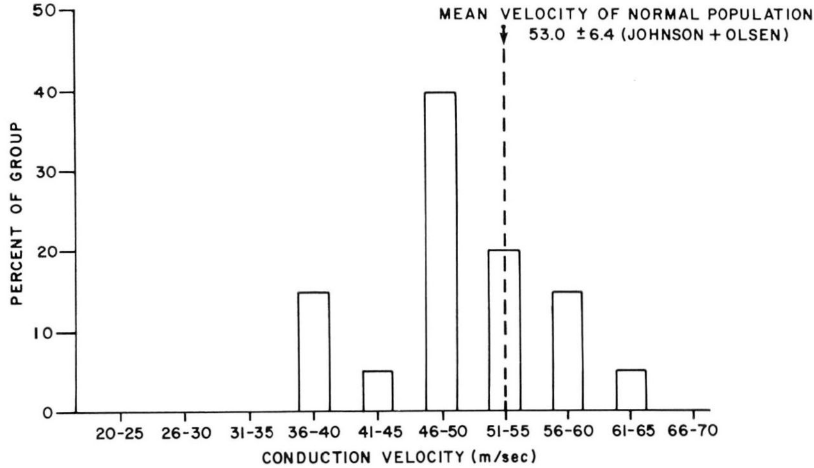

Fig. 1. Median-nerve conduction velocities in 20 young diabetics. (Median according to Johnson and Olsen.[7])

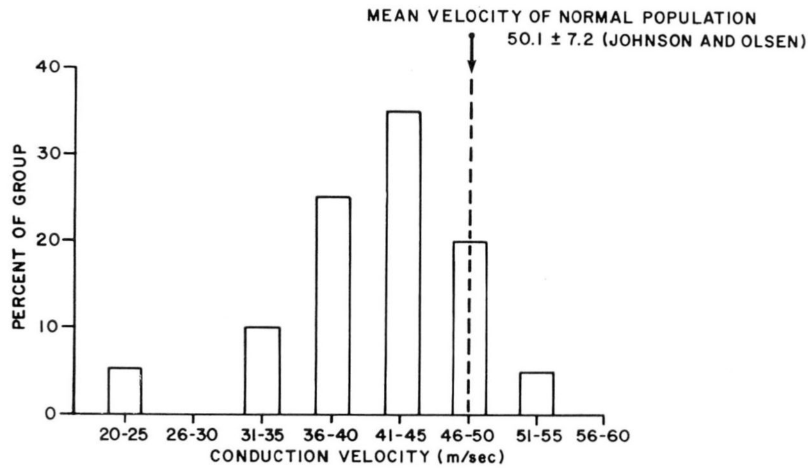

Fig. 2. Peroneal-nerve conduction velocities in 20 young diabetics. (Median according to Johnson and Olsen.[7])

second (49 to 41 m per second). We calculated from our standard error of the mean that the probability of obtaining as large a difference as 8 m per second from errors of random sampling was less than one in a thousand.

Median nerve. The mean for the young diabetic patients, and the mean for a normal group as reported by Johnson and Olsen[7] were fairly close (49.5 and 53 m per second, respectively). To determine whether the means

Table 1.—*Comparison of motor-nerve conduction velocities in young diabctics and in normal persons*

Subjects	Conduction velocity, m/second: Median nerve, Mean ± S.D.*	Median nerve, Mean ± S.E.†	Peroneal nerve, Mean ± S.D.*	Peroneal nerve, Mean ± S.E.†
Cleveland Clinic young diabetic patients	49.5 ± 7	49.5 ± 1.6	41 ± 6.5	41 ± 1.5
Normal persons[7]	53 ± 6	53 ± 0.8	50 ± 7	50 ± 0.6
Normal persons[8]	59 ± 4	59 ± 0.6	49 ± 6	49 ± 1

* S.D. = standard deviation.
† S.E. = standard error of the mean.

Table 2.—*Motor-nerve conduction velocities in diabetic patients*

Patients	Patients: Number	Patients: Age range, years	Nerve conduction velocity, m/second: Median	Nerve conduction velocity, m/second: Peroneal
Cleveland Clinic	20	5–23	49.5	41
Mayer[4]	23	10–35	51	43
Mulder and associates[3]	103	11–79	50	43
Johnson and Olsen[7]	103	12–87	—	39

differed significantly we calculated a standard error for the difference between means. The equation

$$S \frac{N_1 + N_2}{N_1 N_2},$$

where

$$N_1 = 20, N_2 = 68, \text{and } S = 7.09,$$

was assumed to be applicable to calculate this standard error, because the standard deviation of our mean and that of Johnson and Olsen[7] were nearly equal. From the difference between means (3.5 m per second) and the standard error of the difference (±8 m per second) we calculated a value of 1.94 for t. A table distribution of t showed that with the 86-degree freedom this value could be exceeded by chance only five times in a hundred.

Wrist latency. A review of the latency response to stimulation of the median nerve at the wrist showed values from 2.4 to 6.5 msec. Three patients had values greater than 5.0 msec, which is customarily used as the top normal value. The mean value was 4.0 msec.

DISCUSSION

The significance of motor-nerve conduction velocity determinations in young diabetics is not generally realized, even though two studies have been reported.[8, 9] Our study revealed a decrease in the mean value of the conduction velocity both for the median and for the peroneal nerves, with the greatest decrease from the normal in the peroneal nerve (49.5 and 41 m per second, respectively). These values are lower than those reported in the literature for the median and peroneal nerves in a healthy population (*Table 1*). In reviewing the data on the peroneal nerve, only one patient had a motor-nerve conduction velocity higher than 50 m per second, the mean for a normal population. Forty percent of the peroneal-nerve conduction velocities were less than 40 m per second, which most electromyographers consider the lowest limit of the normal range. The velocities reported herein are comparable to those obtained by investigators among the adult diabetic population (*Table 2*). This lessening of the conduction velocity in young diabetics who are relatively free of symptoms, lends additional support to the theory that an early and clinically unrecognizable dysfunction of the peripheral nervous system may be present in diabetic patients of any age.

Age apparently affects the nerve-conduction velocity of motor nerves. Adult values were found to have been reached in children about two years of age.[7] Since it was reported that nerve-conduction velocity decreases in the older age group, Skillman and associates,[2] Mulder and associates,[3] and Mayer[4] investigated this effect upon their findings of lowered nerve-conduction velocity in adult diabetics. The consensus seems to be that age is not a factor in the lowered nerve-conduction velocity of the diabetic patients.

It should be emphasized that patients with either overt or hidden diabetes mellitus have nerves that are more vulnerable to trauma than are nerves of normal persons. Cases have been reported in which asymmetric motor neuropathy was the presenting symptom that led to the diagnosis of diabetes mellitus when the typical diabetic triad of symptoms was lacking.[10, 11] In other instances, stress situations have precipitated the onset of neuropathy.[12] In that study[12] one patient had severe pain low in the back and the gluteal region, and another had symptoms of radiculopathy in the lower extremity. After extensive investigation no diagnosis could be made other than the previously known diabetes mellitus.

Eliasson's[13] experimental studies, on rats, show a definite slowing both of motor-nerve and of sensory-nerve conduction velocities soon after induction of mild diabetes by alloxan. Perhaps this drug-induced decrease in nerve-conduction velocity is additional evidence of an altered nerve function in diabetics before minimal changes in the neurologic status can be recognized clinically. With the determination of nerve-conduction velocities, in diabetic patients, the preclinical form of neuropathy can be easily and accurately diagnosed.

SUMMARY

Motor-nerve conduction velocities were determined on the median and the peroneal nerves of 20 young (from 5 to 23 years old) patients with diabetes mellitus. A comparison of the nerve-conduction velocities in these patients with those of a normal population reveals a statistically significant lowering of the means for the young diabetic group. This difference was more pronounced in the lower extremities.

The determination of the motor-nerve conduction velocity is an objective test that is relatively easy to perform and easily reproduced, causing minimal discomfort to the patient. The test permits early detection of changes in peripheral nerves before overt neuropathy develops, and it provides a reproducible means of following nerve alterations.

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