



Sensory and Motor Peripheral Nerve Findings in Patients with Diabetes Mellitus Referred for Electrodiagnosis

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Keywords

Diabetes mellitus; Peripheral neuropathies; Electrodiagnosis

Abstract

Background: Diabetes mellitus (DM) is the most prevalent endocrine disease and the most common cause of peripheral neuropathy, which is one of the important long-term complications of diabetes. Careful neurologic examination and electrodiagnosis are essential and valuable to the early diagnosis of neuropathy and prevention of its consequences. The aim of this study was to assess electroneurographic findings in patients with diabetes.

Methods: This study was conducted on 103 randomly selected patients with diabetes who referred for electroneurographic studies. Neurologic and electroneurographic examination were performed in all patients. Moreover, 3 motor nerves (M-median, deep peroneal, and tibial) and 3 sensory nerves (S-median, sural and superficial peroneal) were evaluated and in each nerve its conduction velocity, distal latency, and amplitude were assessed. Furthermore, bilateral H-reflex was measured in the soleus muscle.

Results: Among the 103 studied subjects, 30 patients (29.1%) had type I DM and 73 (70.9%) had type II DM. The overall incidence of diabetic neuropathy was

79.6%. There was a direct correlation between disease duration and prevalence of diabetic neuropathy. The most common complaint was numbness and tingling of distal parts (72.0%) ($P < 0.0001$). The most common physical finding was abnormal ankle jerk (94.0%) ($P < 0.0010$). The most sensitive finding in electroneurographic examination was absent or prolonged H-reflex (92.5%) ($P < 0.0001$). Overall, the amplitude was a more sensitive parameter than distal latency.

Conclusion: Nerve conduction parameters especially H-reflex study and amplitude of sensory responses are valuable in the early diagnosis of diabetic neuropathy. There is a good correlation between clinical and electroneurographic findings; thus, clinical examination is highly recommended in order to prevent unnecessary work-ups, and help prevent untoward complications.

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Introduction

Diabetes mellitus (DM) is the most common endocrine disorder and the most prevalent cause of peripheral polyneuropathy.¹

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The cause of diabetic neuropathy is unknown. Peripheral vascular involvement is common in DM; however, there is no direct relationship between the severity of vascular diseases and polyneuropathy and autonomic neuropathy. Its ischemic origin has been proven based on autopsy reports of patients with localized mononeuropathy and multifocal diabetic neuropathy; in addition, vasa nervorum obstruction has been observed in association with infarction of nerve fascicles and small infarctions in the lumbar plexus. In some studies, DM neuropathy has been associated with axon transport and neurotransmitters.¹⁻⁴

Blood glucose control within its normal range improves the conduction velocity of motor nerves, reduces the progression of neuropathy, and sometimes ameliorates neuropathic symptoms.⁵ However, there is some evidence that neuropathy progresses despite controlling the blood glucose.^{1,3}

In patients with DM, finding ways to expeditiously diagnose neuropathy in its early stages by spending the least amount of time and cost is of great importance. In this study, electroneurographic tests, a comfortable and safe method accepted by patients, were performed to determine the neurotransmission rate in the sensory and motor nerves among patients with DM.

Methods

This descriptive-analytic study was carried out on patients with DM who were referred to a private clinic for an electroneurographic examination. Information regarding disease duration, type of DM, history of underlying illnesses (to exclude patients suspected of peripheral nerve involvement because of other causes), patient complaints, and type of medication was obtained from the patients. In the next step, the clinical examination of the organs, including muscle strength, ventricular reflexes, vibration thresholds, and position sensations, were performed.

In the electroneurographic examination, 3 motor nerves [motor median (m-Med),

deep peroneal nerve (DPN), and tibialis posterior (Tib)] and 3 sensory nerves [sural nerve (SN), superficial peroneal nerve (SPN), and sensory median (S-median)] were examined. In each of these 6 nerves, nerve conduction velocity (NCV), distal latency (DL), and amplitude (AMP) tests were performed. Moreover, H-reflexes were measured in the soleus muscle of both legs. All electroneurographic tests were performed using the Synergy device (Medelec, UK) in a standardized mode.⁶ The temperature of the patient's organ was compared to the skin of the examiner and warmed up if it was colder.

In conducting the electroneurographic tests and clinical examination, the researcher tried to observe all the standard items in the measurements in order to minimize the error rate. The presence of disturbance in at least 2 of the electroneurographic findings with at least 1 abnormal finding in the clinical examination was considered as peripheral nerve involvement in the patient caused by DM. Finally, the data were analyzed using SPSS software (version 13.0, SPSS Inc., Chicago, IL, USA) and P-values of less than 0.05 were considered significant.

Results

Out of 103 patients, 67 (65.0%) and 36 (35.0%) were women and men, respectively. In addition, the age range of the patients was 12-77 years with a mean \pm standard deviation (SD) of 52.6 ± 8.4 years. Moreover, 30 (29.1%) and 73 (70.9%) of the patients, respectively, suffered from type I and type II DM. Among the subjects, 82 (79.6%) and 21 (20.4%) had and lacked peripheral nerve involvement, respectively. Among the patients with type I and type II DM, 27 (90.0%) and 55 (75.0%) patients had peripheral nerve involvement, respectively. In terms of age, there was no significant difference between various age groups in the two groups of patients with and without neuropathy ($P < 0.0500$).

A minimum of 4 months and maximum of 32 years had passed since the diagnosis of the disease in the subjects.

Table 1. Comparison of mean neurotransmission rate in groups with and without neuropathy (m/s)

Neuropathy status	Superficial peroneal	S-median	Sural	m-Med	Motor tibial	Deep peroneal
Suffering	11.8	36.0	24.2	50.6	37.3	36.1
Non-suffering	40.5	52.5	48.8	53.4	44.2	45.3
P	0.00001	0.00010	0.00010	0.06000	0.00001	0.00001

S-median: Sensory median; m-Med: Motor median

The minimum, maximum, and mean duration since diagnosis in patients with neuropathy were 3 months, 32 years, and 16.1 ± 4.5 years, respectively, which were higher than those among individuals who did not have neuropathy (4 months, 15 years, and 7.4 ± 2.7 years, respectively); the difference was statistically significant ($P < 0.0500$).

The most common complaint of patients was the feeling of numbness and tingling in the upper or lower extremities, or both. Pain was the second most common cause of complaints among the patients. The prevalence of these two subjective findings was significantly different compared to that reported by those who lacked neuropathy ($P = 0.0001$ and $P = 0.0020$ for tingling and pain, respectively).

The reduction of the ankle reflex (94% sensitivity) was the most sensitive clinical finding in diabetic neuropathy. Moreover, There were 19% false positive cases (specificity of 81%) in this group, which differed significantly ($P = 0.001$) with the group without neuropathy. The lowest sensitivity was associated with the abnormality of the sense of position in the leg (12% sensitivity); however, this examination had 100% specificity (no false positive cases). Although the difference was not statistically significant ($P = 0.2000$), abnormal ankle reflexes, vibration sensation in the legs, knee reflexes, and feeling of vibration of the hands with rates of, respectively, 94.0%, 76.0%, 67.0%, and 63.0% were higher among patients with diabetic neuropathy compared

to those without neuropathy.

The most sensitive diagnostic parameter in diabetic neuropathy was an abnormal H-reflex (sensitivity of 92.6% and specificity of 100%). Generally, the AMP and DL parameters had higher and lower sensitivity, respectively, and the NCV sensitivity was within the range of these sensitivities. The sensitivity of abnormal AMP in the diagnosis of diabetic neuropathy was significant in the sural nerve, superficial peroneal nerve, and sensory nerves (S-median), and deep peroneal (80.0, 79.0, 76.0, and 74.0%, respectively). The superficial peroneal nerve and the sural nerve were not measurable in, respectively, 74.0% and 50.0% of the cases. In addition, the peroneal nerve was not measurable in 9.0% of patients lacking neuropathy (2 out of 21), but this rate was 0.0% for the sural nerve.

The abnormal NCV sensitivity was 79.0%, 58.0%, and 53.0% in the diagnosis of diabetic neuropathy in the superficial peroneal nerve, sural nerve, and the S-median nerve, respectively. The sensitivity of motor nerves was less important in comparison to sensory nerves.

The sensitivity of abnormal DL in the S-median and m-Med nerves was, respectively, 91.0% and 84.0% higher than the other nerves.

Findings of the comparison of the mean NCV and the AMP in the two groups of patients with and without neuropathy have been presented in tables 1 and 2.

Table 2. Comparison of mean neural wave amplitude in groups with and without neuropathy (mV)

Neuropathy status	Superficial peroneal	S-median	Sural	m-Med	Motor tibial	Deep peroneal
Suffering	2.3	14.1	5.7	5.9	3.5	1.5
Non-suffering	7.6	29.3	11.5	7.9	5.3	2.9
P	0.00001	0.00001	0.00001	0.04000	0.01000	0.00100

S-median: Sensory median; m-Med: Motor median

Discussion

Peripheral nerve involvement is one of the most prevalent complications among patients with DM. In various studies, the incidence of diabetic neuropathy has been reported to vary between 5.0% and 80.0%.⁷ In this study, of the 103 participants with DM, 82 (79.0%) suffered from neuropathy.

In previous studies, there has been a direct relationship between disease duration and the increased incidence rate of the disease.⁷ In the current study, there was also a significant difference in disease duration between the two groups of patients with and without neuropathy. However, in terms of the age prevalence, there was no significant statistical difference among different age groups in terms of the incidence of diabetic neuropathy. Nevertheless, in some studies, the prevalence of diabetic neuropathy was also reported to increase with age.⁸

In some valid references, the feeling of distal pins and needles and, in some others, pain have been reported as the most common complaint of patients with diabetic neuropathy.⁵ In the present study, the most common complaints of patients included numbness and tingling followed by pain, and the difference between the rates of these two complaints was significant.

In some studies, the reduction in tactile sensation and, in other studies, the reduction of the sense of vibration have been mentioned as the most important clinical findings in peripheral neuropathy.⁹ In a study, the reduction in vibration and tactile sensations ranked lower than findings such as decreased deep tendon reflex.⁹ In the present study, reduction in the deep tendon reflex was the most sensitive clinical finding in patients with diabetic neuropathy (sensitivity 94.0%). In a study conducted on neuropathic patients in general, this clinical finding had a sensitivity of 95.0%.⁹ In another study, the ankle and knee reflexes were abnormal in 66.0% and 45.0% of individuals, respectively; in addition, the vibration and position sensation had been impaired in 24.0% and 8.0% of individuals,

respectively.¹⁰ The reduction of the deep tendon reflex among patients with neuropathy cannot be directly related to muscle weakness and may be due only to the involvement of the afferent and efferent nerves associated with the muscle spindle.¹¹

In the present study, the sensitivity of clinical findings was, by decreasing order, the deep ankle reflex, decreased sense of vibration in the feet, decreased deep knee reflex, and decreased sensation of vibration in the hands. In addition, the least sensitivity in diagnosis of diabetic neuropathy was related to position sensation in the feet. Although this examination had a 100% specificity and there were no false positives, the increase in the threshold for vibration perception had a sensitivity of 73.0% and a false-positive rate of 7.0%.¹²

The abnormal H-reflex is the most sensitive diagnostic test for diabetic neuropathy (sensitivity of 92.6%) and has been confirmed in other studies.⁹ In the current study, H-reflexes had high sensitivity (100%) and high specificity. This finding is in contrast with the previous beliefs that this test has a low specificity for the diagnosis of diabetic neuropathy. Regarding the fact that in this study patients with diabetic neuropathy were not compared with a control group (patients without DM), in terms of specificity, its value was less than cases with a control group and this may be the cause of the difference in the specificity of H-reflex. However, there were no false positives in this study.

In examining the NCV parameter, sensory nerves were more sensitive compared to motor nerves and this difference was statistically significant. In addition, in examining the DL parameter, except for the peroneal and sural nerves, DL had no significant sensitivity in the diagnosis of DM neuropathy. Similar results were obtained in similar studies.⁹ However, the DL of the median (sensory and motor) nerves had a very good sensitivity in this study. However, due to the presence of a pressure region on

the median nerve in the wrist area and the probability of carpal tunnel syndrome (CTS), the importance of increasing the DL in these two nerves in the neuropathic diagnosis decreases. If this pressure is considered a phenomenon separate from diabetic polyneuropathy, this parameter may not gain a high diagnostic value. In this case, following the abnormality of H-reflex, the most sensitive diagnostic test was the reduction of amplitude in the sural as well as the superficial peroneal and deep peroneal nerves; these findings were consistent with the reports in previous studies.^{9,13}

Conclusion

Regarding the high incidence rate of neuropathy among patients with DM and its associated physical complications and impact on the quality of life (QOL) of patients, especially in patients who have suffered from DM for several years, considering the clinical symptoms of neuropathy, and then,

complementary investigations using electroneurographic studies can be very helpful in its early diagnosis. In order to accurately diagnose neuropathy, especially in its mild or subclinical forms, it is recommended that several NCV parameters, including H-reflex and sensory wave amplitude, be taken into account in different organs.

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Conflict of Interest

Authors have no conflict of interest.

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