Investigation of Nerve Conduction in Patients with Diabetes and/or Hemodialysis

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Abstract

Diabetic peripheral neuropathy (DPN) has been clinically important, and nerve conduction studies (NCS) have been performed with rather complexity and high cost. By advances in technology, simple and useful DPN-Check device was developed obtaining NCS data as sural nerve conduction velocity (SNCV) and sural nerve action potential (SNAP). We enrolled 52 subjects classified into 4 groups according to the presence of hemodialysis (HD) and diabetes mellitus (DM) as follows: HD (+), DM (+) in group 1, HD (+), DM (-) in group 2, HD (-), DM (+) in group 3 and healthy controls in group 4. Average age was similar from 68 to 74 years in 4 groups. Median value of SNCV was 31, 48, 49, 54 m/sec, and median value of SNAP was 3, 9, 6, 22 μV, respectively, in 4 groups. These results might suggest some relationship between impaired states of HD and DM, and would become fundamental data for pathophysiological investigation of peripheral neuropathy of HD and/or DM in the future.

Keywords

DM: Diabetes Mellitus; HD: Hemodialysis; DPN: Diabetic Peripheral Neuropathy; SNCV: Sural Nerve Conduction Velocity; SNAP: Sural Nerve Action Potential

Introduction

Neuropathy is one of common micro-angiopathic complication of diabetes, and observed more than half of diabetic patients [1, 2]. Historically speaking, diabetic peripheral neuropathy (DPN) has been diagnosed based on medical history, physical exam and some simple in-office tests [3, 4]. While this testing is easy to perform, it is limited in terms of its accuracy. On contrast, nerve conduction studies (NCS) had provided a greater degree of accuracy, but the complexity and cost of the testing have excluded their use in a routine evaluation [5, 6].

Advances in technology have now made available the ability to perform in-office nerve conduction testing. Using sural nerve in calf and ankle, simple and useful DPN-Check device enables to obtain accurate nerve conduction data for the assessment of DPN [7, 8].

We have reported lots of studies concerning diabetes including low carbohydrate diet (LCD), lipid metabolism and ketone bodies [9-11]. In this study we investigated NCS in patients with diabetes mellitus (DM) and/or with chronic hemodialysis (HD).

Research Protocol and Results

In this study, 52 subjects were enrolled classified into 4 groups. The classification was done according to the existence of HD and/or DM (Table 1). Group 1 has 12 patients with HD and DM, Group 2 has 12 patients with HD and without DM, Group 3 has 14 patients with diabetes and without nephropathy and Group 4 included 14 normal healthy subjects without diabetes or renal diseases which ages were close to other 3 groups.

Table 1 : Characteristic of the Subjects

| Classification	Group 1	Group 2	Group 3	Group 4
Treatment of Hemodialysis	Present	Present	None	None
Treatment of Diabetes	Present	None	Present	None
Subject age (Year old) Median [25% - 75%]	71 [64-73]	74 [71-76]	73 [63-83]	68 [57-78]
History of hemodialysis (year) Median [25% - 75%]	5.8 [4.7-6.4]	11.1 [4.5-13.4]	-	-
History of hemodialysis mellitus (Year) Median [25% - 75%]	23 [11-34]	-	14 [11-19]	-

We used recently developed device, HDN-1000, NeuroMetrics Inc., USA (registered No. 226AABZI00091000). This device can measure SNCV and SNAP at the sural nerve in the lower calf and ankle. Electrical stimulation is performed on the back side of the ankle, and measurement is performed with a biosensor installed 9.22 cm ahead of the stimulation probe. HDN-1000 has included lots of research results based on validated technologies [12, 13]. The standard normal range is more than 48 m/sec for SNCV and more than 6 μV for SNAP [5, 8].

As to statistical analyses, obtained data was represented as the mean ± standard deviation (SD) and also represented median, quartile of 25% and 75% in biomarkers. Current study was conducted in compliance with the ethical principles of the Declaration of Helsinki. The authors declare that they have no conflicts of interest.

We measured SNCV and SNAP of the subjects in 4 groups. The results of SNCV were shown in Figure 1. SNCV revealed normal range in group 3 and 4, but several cases revealed remarkable decreased SNCV in group 1 and 2 (Figure 1). Medium value in group 1 was remarkably decreased a compared with those of group 2, 3, 4.

The results of SNAP were shown in Figure 2. SNAP revealed normal in group 4, but median value of group 1, 2, 3 was decreased compared with that of group 4 (Figure 2). In particular, SNAP level in group 1 is remarkable decreased compared with other groups.
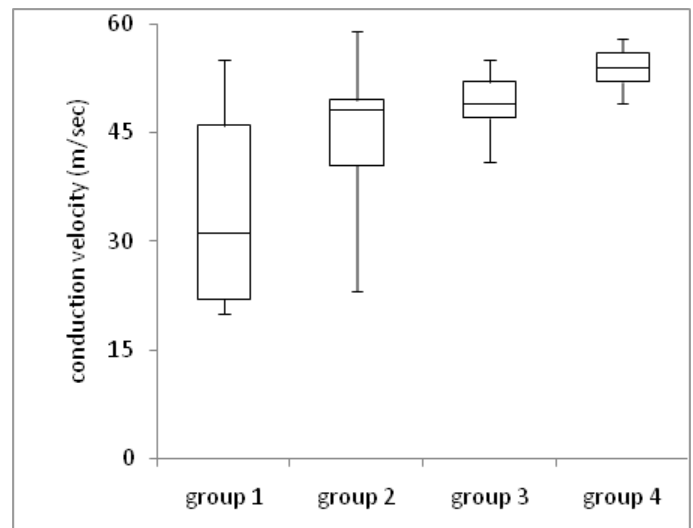
Figure 1: Nerve conduction velocity (NCV) in 4 groups

Group 1: HD (+), DM (+), Group 2: HD (+), DM (-), Group 3: HD (-), DM (+), Group 4: HD (-), DM (-).
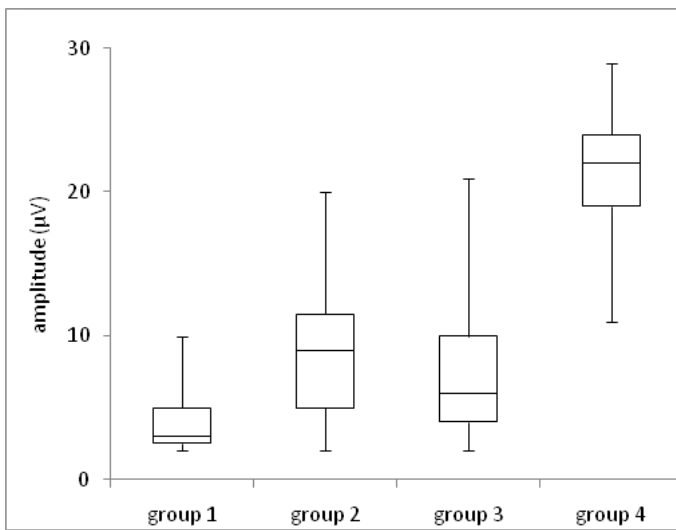
Figure 2: Action potential (amplitude) in 4 groups

Group 1: HD (+), DM (+), Group 2: HD (+), DM (-), Group 3: HD (-), DM (+), Group 4: HD (-), DM (-).

Discussion

This study focused the SNCV and SNAP in patients with DM and HD and the influenced factors about neuropathy would be speculated. As to diabetic neuropathy, it has been known that carpal tunnel syndrome frequently occurs in diabetic patients. Many cases are pointed out as median neuropathy (MN) at the wrist during asymptomatic period in NCS. MN is frequently observed in early stages when DPN was not observed, then it may be regarded as an early lesion of DPN [14, 15].

In recent years, a new device of HDN-1000 was released, which can measure the nerve conduction velocity of the sural nerve easily. As to the results of SNCV and SNAP by HDN-1000, both show nearly equivalent numerical values as compared with the conventional nerve conduction test, and their usefulness has been evaluated [8]. It included lots of research results based on validated technologies [5, 12, 16, 17]. Clinically, the standard normal range of the sural nerve has been that CV is 50 m / s or more and amplitude is > 10 μV.

There are remarkable decrease of SNAP in group 1 and 3 compared with that of group 4. One of the reasons for decreased SNAP in diabetics would be from decreased intraepidermal nerve fiber density (IENFD) [18]. IENFD can be observed with a confocal microscope, by a 3 mm diameter punching needle biopsies at 10 cm above the ankle of the lower extremity with fixes and immunostaining. IENFD falls from the early stage of DPN and declines in correlation with the progression of stage [19].

Furthermore, there are also decrease of SNAP in group 1 and 2 compared with that of group 4. Uremic Neuropathy (UN) was observed in 16.4% of patients with chronic hemodialysis, and these patients showed a significant correlation between questionnaire scores and nerve conduction velocity / sensory nerve action potential [20]. Peripheral neuropathy in patients with DM and chronic kidney disease (CKD) might be from some correlation between hyperkalaemia and development of nerve dysfunction [21]. End-stage renal failure in diabetic patients is often associated with severe distal motor and sensory deficits [22].

This study showed decreased SNCV and SNAP in patients with diabetes and/or with chronic hemodialysis, but has limitation for certain speculation because of small numbers. These results would become the fundamental data for future investigation of NCS for DM and HD.

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