ORIGINAL RESEARCH

Determination of Median Nerve Conduction Velocity and F-wave Minimal Latency to Diagnose Early Onset of Diabetic Neuropathy

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Abstract

Diabetes mellitus is a metabolic disorder characterized by many abnormalities and leads to long term complications like diabetic neuropathy, nephropathy, and retinopathy. Diabetic peripheral neuropathy causes symptoms of peripheral nerve dysfunction. Sensory nerve conduction velocity (SNCV), distal sensory latency and F-waves minimal latency of median nerve are important parameters of electro diagnosis for early detection of diabetic neuropathy. The objective of the study was to determine the specificity and sensitivity of the sensory nerve conduction velocity and F-wave minimal latency of median nerve in diabetic subjects in early detection of diabetic neuropathy. Thirty subjects recruited for the study were divided into group A comprising of healthy subjects (n=10, age: 62.70 ± 10.49 years) and group B consisting of diabetic subjects (n=20, age: 68.05 ± 6.44 years). NICOLET VIKING QUEST instrument was used for the nerve conduction velocity test. SNCV of the median nerve significantly decreased in diabetic subject when compared with control group. However, the F-wave minimal latency was not specific and sensitive over SNCV to diagnose early diabetic neuropathy in clinically asymptomatic patients. We concluded that sensory nerve conduction velocity was much more sensitive and specific than F-wave minimal latency to detect early diabetic neuropathy.

Keywords: Diabetic neuropathy, F-wave minimal latency, Median nerve conduction velocity.

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Introduction

Diabetic neuropathy is defined as presence of symptoms and signs of peripheral nerve function or there is some interference in the functions of the peripheral nerve function in people with diabetes. Mononeuropathies may affect peripheral nerve like median, ulnar, peroneal, sciatic, femoral, and cranial nerves. The study of median nerve conduction velocity can provide insight to the severity of the effects of diabetes on median nerve. Sensory nerve conduction velocity and distal sensory latency along with the F-wave minimal latency can give prior information about the neuropathy and decide the severity of the neuropathy. It is well established that diabetes leads to various complications, the most common being peripheral neuropathies. Evaluation of peripheral neuropathies is one of the most frequent indications of electro diagnostics examinations. Infact, the most significant diagnostic criteria for diabetic neuropathy confirmed by experts are disturbances in nerve conduction velocity, augmented threshold of sensory nerves, and disturbances in autonomic system function tests.[1] F-waves examined during this examination are more sensitive than conventional motor conduction studies in axonal neuropathies. It is a more stable and reliable parameter to detect any abnormality. The F-waves are low amplitude late responses produced by activation of motor neurons. F-waves minimum antidromic latency and sensory nerve conduction velocity of median nerve, were evaluated. Minimum latency is generally most useful in neuropathies. Evaluation is carried by determining mean latency of F-waves to compare latencies. The latencies of F-waves are prolonged in neuropathies.

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The F-wave uses supramaximal stimulation of motor nerve and records the compound muscle action potential. The F-waves occurs after direct motor potential or the M-response with more proximal stimulation the latency of M response increases while that of F decreases. F-wave travels away from the recording electrode and goes towards the spinal cord before it reaches to the activated distal muscles. There are three latency parameters for an F-wave such as the minimal, mean and the maximal latency. Minimum F-waves have fastest conducting fibers and maximal F-waves have slowest conducting fibers.[2]

Researchers showed normal median nerve activity using the shortest and average F-wave latencies and measured the motor response latency from wrist and elbow stimulation sites by conventional techniques.[3] They observed that there was no significant difference in F-wave latency.[3] F-wave is an important tool for evaluating the

normal physiology of the peripheral and central nervous system. The current evidence supports F-waves having a role in electrophysiological evaluation of lumbosacral radiculopathies.[4] The gender, age and height had a major role in F-wave latency determination, and it was reported that there was a positive correlation between height and median nerve F-wave minimum latency.[5] Monitoring of F-wave latency may aid early detection of not only diabetes neuropathy but also left ventricular dysfunction.[5] Decrease in sensory nerve conduction velocity findings are consistent with the study which shows that sensory nerve conduction velocity was higher in control group as compared to diabetics motor nerve conduction velocity findings were inconsistent there was no significant difference noticed in conduction velocity of diabetics and control group. Both motor and sensory nerve conduction velocity decreased with increase in duration of type 2 diabetes mellitus (T2DM).[6] F responses are late responses which are obtained by supramaximal stimulation of virtually all motor and mixed peripheral nerves. They are recorded over a muscle innervated by stimulated nerve. F-wave recording method is mandatory for reliable and meaningful analysis. Physiological factors, which influence F-waves, are ageing, sleep, drugs. Also, it is emphasized that F-waves are particularly useful for diagnosis of polyneuropathies at a very early stage and for the diagnosis of proximal nerve lesion.[7]

Difference between distal sensory latency of median and ulnar nerve were taken, specifically for diagnosing CTS at an early stage. A study on F minimal wave latency (FMWL) with only 10 stimuli for obtaining median FWML was done, and it proved to be the primary explanation for low sensitivity and specificity of median nerve in diabetic population (8). The median nerve conduction velocity can be used to assess early asymptomatic neuropathy in diabetes mellitus.

The aim of the present study was to find out the sensory nerve conduction velocity and F-wave minimal latency of median nerve in diabetic type 1 and type 2 subjects and also to determine their specificity and sensitivity in early detection of diabetic neuropathy.

Materials and Methods

Subjects

Study was conducted in a hospital at Delhi and performed in accordance with the ethical standards of the hospital. Thirty subjects were recruited for the study by randomization. Group A comprised of healthy subjects (control group, n=10) and their age (Mean ± SD) was 62.70 ± 10.49 years. Group B comprised of twenty men and women and their mean age was 68.05 ± 6.44 years and was suffering from diabetes mellitus both type 1 and type 2. The duration of diabetes of subjects was from 3–15 years and was selected randomly. The nerve conduction velocity of median nerve was measured. Any cases of polyneuropathies, radiculopathies, rheumatoid arthritis, trauma, hypothyroidism, pregnancy, and chronic alcoholics were excluded from the study.

Subject Preparation

The subjects were prior informed about the principles, procedures, and benefits of the test.

Each patient signed the consent letter. All the guidelines were explained to the subjects, and they were made aware that the test was a nerve conduction velocity test of the median nerve which will explore whether they are at risk of getting diabetic neuropathy or carpal tunnel syndrome. With the help of this test they will be able to know about their lifestyle and the type of modifications required for leading a better life. The skin of patient was exposed and prepared with the new-prep gel. The ambient room temperature was kept at 22–25°C. The testing room was free from any kind of noise and subjects were made comfortable before the commencement of the experiment.

Materials Required

NICOLET-Viking quest machine (model no-0086), made in U.S.A. was used to check the nerve conduction velocity. NUPREP skin gel was used for the cleaning of skin. Conductive neurodiagnostic electrode paste was used to increase conductivity. Stimulating electrodes, recording electrodes and ground electrodes were used for this study.

Methods

Sensory nerve conduction studies and F- wave minimal latency studies were performed according to standard techniques. The bipolar method of testing was used to stimulate the median nerve. The skin of subject was exposed, and it was prepared with new –prep gel for good conduction of currents. The electrodes were placed at respective points of stimulation.

Placement of the Electrodes

Surface Electrodes Used: For sensory nerve conduction velocity (orthodromic SNCV of median nerve) surface recording electrode was placed 3cm proximal to distal wrist crease and the reference electrode was placed at 3 cm proximal to recording electrode. For stimulation ring electrodes were fixed on the second digit. The surface electrode was placed in a belly tendon montage to record the F-wave response.

Statistical Analysis

Student unpaired t-test was applied to compare mean differences between control and experimental groups. The statistical significance was observed at $p < 0.05$. The data for different electrophysiological parameters measured in controls and the diabetic subjects was represented as Mean ± SD.

Results

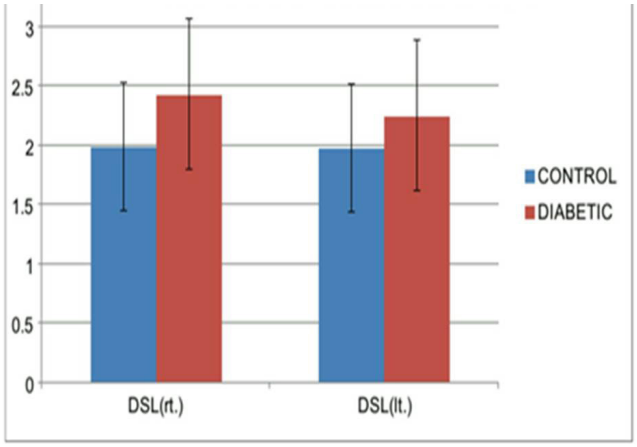
Nerve conduction velocities in control (Group A) and diabetic subjects (Group A) were measured which are presented in the figures given below.

The distal sensory latency of median nerve in both control and diabetic group were compared and presented in Fig. 1. It showed that the distal sensory latency within control group and diabetic subjects was insignificant at $p > 0.05$. DSL of right and left median nerve was 1.99 ± 0.54 and 1.98 ± 0.53 ($p > 0.05$), respectively in control group whereas in diabetic group 2.43 ± 0.68 and 2.25 ± 0.64 ($p > 0.05$), respectively.

Fig. 2 showed the comparison between the sensory nerve conduction velocity of the median nerve in controls and diabetic groups. The sensory nerve conduction velocity in right and left side within controls and diabetic subjects was insignificant at $p > 0.05$. Sensory nerve conduction velocity of right and left median nerve was 46.70 ± 2.95 and 46.60 ± 3.83 in control group, respectively and in diabetic group was 35.75 ± 7.45 and 36.70 ± 6.95, respectively ($p > 0.05$).

F-wave minimal latency (FWML) of median nerve of both right and left upper limb in controls and diabetic subjects was compared. FWML within control group and diabetic subjects was insignificant at $p > 0.05$. F-waves minimal latency of median nerve of control group of right and left sides were 26.90 ± 1.27 and 29.70 ± 4.77, respectively. F-waves minimal latency of median nerve of control group of right and left sides were 26.90 ± 1.27 and 29.70 ± 4.77, respectively. F- Waves minimal latency of median nerve of diabetic group of right and left sides were 27.84 ± 7.82 and 27.03 ± 5.37, respectively.

The sensory nerve conduction velocity was significantly decreased in diabetic subjects as compared to control group as shown in Fig. 2. The decrease in sensory nerve conduction velocity gives prior information that the person suffering from diabetes could even develop diabetic neuropathy afterwards. The mean sensory nerve conduction velocity in diabetic subjects was 35.75 m/s for right upper limb and 36.70 m/s for the left upper limb. The mean differences were highly significant ($p < 0.001$).

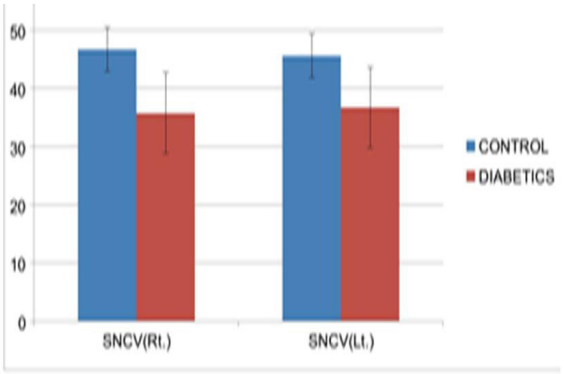


p < 0.05

Fig. 1: Comparison between the distal sensory latency (DSL) of median nerve for both the right and left upper limb in control and diabetic subjects.

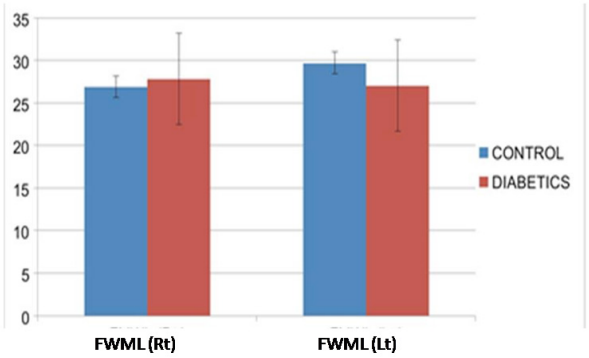
Discussion

The present study showed that there was significant decrease in both sensory nerve conduction velocity and distal sensory latency of median nerve of diabetic subjects with mild clinical features of neuropathy as compared to healthy subjects. The sensory nerve conduction velocity was found to be 35.75 m/s of right upper limb and 36.60 m/s of the left upper limb in diabetic subjects both were significant at $p < 0.005$. The American association of electro diagnostic medicine (AAEM) has concluded that median nerve sensory transmission is also more sensitive indicator for early diagnosis of diabetic neuropathy of median nerve.[9] In our study median nerve sensory nerve conduction velocity was reduced significantly in diabetic subjects as compared to healthy subjects. A reduction of conduction velocity could be the result of a combination of segmental demyelination, loss of fastest conducting axons and variation in metabolic parameters.[10] The electrophysiological diagnosis of diabetic neuropathy is based on conduction abnormalities of median nerve across the carpal tunnel as median nerve has the tendency to compress in the carpal tunnel. Characteristic finding in the early diagnosis of diabetic neuropathy were slowing in



p < 0.05

Fig. 2: Comparison between the sensory nerve conduction velocity (SNCV) of median nerve for both the right and left upper limb in control and diabetic subjects.



p < 0.05

Fig. 3: Comparison between the F-wave minimal latency (FWML) of median nerve for both the right and left upper limb in control and diabetic subjects.

sensory nerve conduction velocity of median nerve, decrease in the sensory nerve action potential. According to our study the sensitivity and specificity of median nerve F-wave minimal latency of both right and left was insignificant. The distal sensory latency was also found to be insignificant at $p < 0.05$ for both upper limbs. The findings of our study was not able to prove superiority of FWML over SNCV. The probable reason for low sensitivity of F-waves can be that F-waves may not appear after each stimulus and also it is variable in configuration.[11] The F-waves minimal latency was 27.84 ms for right median nerve and 27.03 ms for left median nerve in diabetic subjects. The F-wave latency was insignificant at $p > 0.05$.

According to other studies, 40% of diabetic patients had decrease in sensory nerve conduction velocity,[12] 42% of newly diagnosed diabetic type 2 patients had distal medial mononeuropathy,[13] and 14.3% of diabetic patients were found to have asymptomatic carpal tunnel syndrome. Motor and sensory conduction velocity of median nerve in patients with essential hypertension and also suffering from diabetes was not significant.[14] Other studies showed that hand function contributes to quality of life in diabetes and demonstrated a small but significant decrease in motor nerve conduction velocity of median nerve which ultimately has effect on hand functions and quality of life is affected.[15] Further it was also reported that people with clinical neuropathy have a longer duration of diabetes and an increase in age and duration of diabetes can significantly affect the nerve conduction velocity.[1]

Conclusion

We concluded that the sensory nerve conduction velocity was more sensitive and specific than F- wave minimal latency and was very important in early diagnosis of diabetic neuropathy in clinically asymptomatic patients. We strongly consider that further studies, particularly prospective models with large cohort studies and long-term evaluations, would be helpful in understanding the role of nerve conduction studies in patients with subclinical diabetic peripheral neuropathy.

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