Original Article

Nerve Conduction Velocity of Medial and Lateral Plantar Nerve: A Predictor of Diabetic Foot among Diabetic Population

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ABSTRACT

Background: Diabetic foot ulcer, one of the frequent in addition to severe complication of diabetes about 12-25% people has risk of developing diabetes. Diabetic foot ulceration can be identified as a very well-demarcated full thickness injury at distal part of the ankle.

Aim: The aim of the current study was to explore whether medial plantar nerve conduction velocity and lateral plantar nerve conduction velocity can predict the diabetic foot among diabetic population.

Materials and Methods: 50 subjects diagnosed with diabetic mellitus type-2 were recruited based on inclusion and exclusion criteria. Subjects were explained about the NCV. Medial plantar and lateral plantar nerve, both side CMAP (Compound motor action potential) and SNAP (Sensory nerve action potential) were documented.

Results: Results showed that the subjects were having normal conduction in motor NCV in both male and female. There was decrease in root mean square value of sensory NCV of 39.69=M, 38.66=F, lateral plantar sensory nerve left side, showed decrease in the conduction velocity though it was not statistically significant change.

Conclusion: Motor conduction and Sensory conduction velocity of Medial plantar and Lateral plantar nerve could not predict the diabetic foot among diabetic population. There is no significant changes in Medial plantar nerve motor and sensory conduction velocity but left side lateral plantar sensory nerve conduction showed some changes in SNAP though it was not statistically significant change.

Keywords: Diabetic mellitus type-2, diabetic foot, NCV, lateral plantar nerve, medial plantar nerve, CMAP, SNAP.

INTRODUCTION

The diabetic foot syndrome or disease (DFD) comprises numerous pathologies, predominantly diabetic peripheral neuropathy as well as peripheral arterial disease which end in foot ulceration.[1,2] Foot Ulcer is one of the most frequent and severe complication among.[3] India has 3.6% of population affected with diabetic foot ulcers [4,5] The incidence of diabetes mellitus is globally rising; by 2030, estimated to 366 million due extended life expectancy and changing lifestyles.[6] 32 million Indians were diabetics in 2000 according to WHO (World Health Organization).[7]

Currently, India has 40.9 million diabetics and can increase up to 69.9 million by the year 2025 stated by the IDF (International Diabetes Federation).[8] The posterior tibial nerve, distal to the medial malleolus, divides into terminal branches which provide sensory supply to the plantar part of the foot: the main calcaneal branch supplies the medial plantar heel while the medial plantar and lateral plantar nerves innervate the remainder of the sole of the foot.[9] The medial plantar nerve runs along the medial side of the foot in association with medial plantar artery, terminal branches of dorsal tibial artery supplies abductor hallucis, anterior 2/3rd of the medial aspect of sole, plantar surface of 1st, 2nd, 3rd toes and the

medial aspect of the 4th toe and nail beds.[10] Early lesions may arise from exposure of peripheral nerves to hyperglycemia. Two major metabolic perturbations, increased polyol (sorbitol) pathway activity and reduced myo-inositol content, are induced in peripheral nerve by hyperglycemia, are likely factors responsible for structural breakdown of nerves and slowed conduction velocity. [11-13]

NCS are the most effective Electrodiagnostic assessment, [14] standard criterion test to confirm the diagnosis of peripheral neuropathy as it is reliable and valid test for assessing peripheral nerve function, [15-19] Small pads are tapped onto the skin for NCS to gives mild electrical shocks and detects electrical activity. NCS is comparatively simple, non-invasive and timesaving. NCV outcomes depends on many factors filter setting, electrode type, recording site, extremity warmth, assessor's skill and other attributes. [20]

Appropriate variables such as skin temperature, age, height, gender and weight must be evaluated and documented when reporting a NCS as normal or abnormal.[21] Predicting the diabetic foot in pre symptomatic stage would aid in foot care and appropriate measures to prevent complication. The research question was does medial and lateral plantar nerve conduction velocities both sensory & motor predict diabetic foot among diabetic population. No study have evaluated both motor and sensory function of medial and lateral plantar nerve to predict the probable diabetic foot as a complication in diabetics.

Hence, the purpose of this study was to predict diabetic foot among diabetic population by Nerve conduction velocity of medial and lateral plantar nerve.

MATERIALS AND METHODS

A Cross-sectional study design the Subjects living in and around Bangalore, Karnataka during the period of October 2018 and March 2019 (6 months duration). 50 subjects were recruited by convenient sampling method base on inclusion criteria i.e. Both male and female diagnosed with Type-2 Diabetes mellitus, Aged between 30 to 60 years, Recently diagnosed less than 2 years, subjects were excluded if they were diagnosed with Type-1 Diabetes mellitus, chronic alcoholism, severe renal complication, pacemaker, cognitive deterioration and other neurologic disorders such as stroke, nerve injuries, multiple sclerosis.

Procedure

50 subjects based on inclusion criteria were included in the study using convenient sampling method based on sample size calculation, who are medically diagnosed with Diabetes mellitus (Type-2). Ethical approval was obtained from the Institutional Ethics committee. Brief explanation about objective of study was given to all subjects. Written consent was obtained from the subjects and initial data was collected from the subjects. Comprehensive history taking and clinical examination was done in the subjects in organized format. Record of symptoms such as foot ulcer, paraesthesia, hyperesthesia, burning feet, weakness and gait abnormality were recorded. Nerve conduction study was done of all the subjects using RMS EMG EP Mark –II.[23-25] Clinical Neurophysiology unit, the medial plantar and lateral plantar nerves were assessed by recordings the CMAP(Compound Muscular Action Potentials) and CSNAP(Compound Sensory Nerve Action Potentials). At constant room temperature (30^0C) tests were performed to reduce the errors.

Placement for Medial Plantar Nerve[28] and Lateral Plantar Nerve are described in Table 1.Normal values [29,30] of Motor and Sensory Nerve Conduction Studies are described in Table 2.

Table 1: Normal Values of Motor Nerve Conduction Studies & Normal Values of Sensory Nerve Conduction Studies

Nerve	Parameters	On set latency (ms)	Amplitude (mv)	NCV (m/s)
Medial plantar	Mean Standard Deviation	4.5 ± 0.8	12.9 ± 4.8	47 ± 6
	Range	3.2 - 7.4	1.0 - 26.6	34 - 77
Lateral plantar	Mean Standard Deviation	6.4 ± 1.0	6.1 ± 3.3	48.5 ± 5.4
	Range	2.8 - 11.0	1.0 - 16.9	33 - 76

Nerve	Parameters	On set latency (ms)	Amplitude (mv)	NCV (m/s)
Medical plantar	Mean Standard Deviation	2.68 ± 0.48	9.82 ± 3.84	52.85 ± 4.22
	Range	2.2 - 4.4	3 - 20	45 - 64
Lanteral plantar	Mean Standard Deviation	2.77 ± 0.49	4.55 ± 1.79	52.43 ± 4.34
	Range	2.2 - 5	1 - 6	40 - 64

Table 2: Conduction Velocity of Plantar Nerve

Nerve Conduction Velocity							
Nerve	Variables	Right			Left		
		Mean	SD	CV	Mean	SD	CV
Lateral Plantar	Motor	52.55	± 4	7.6	48.33	± 3.38	7
	Sensory	50.23	± 5.85	11.65	48.06	± 5.46	11.36
Medical Plantar	Motor	52.55	± 4	7.6	51.06	± 4.15	8.12
	Sensory	50.23	± 5.85	11.65	48.3	± 5.04	10.44

RESULTS

Statistical analysis of the data was performed using SPSS 16 software; Descriptive statistics were calculated and summarized. These data included the average (mean and standard deviation), Root mean square error, sample standard deviation, Standard Error of the Mean, coefficient of variation (CV%), single factor ANOVA test were used. Significance level was set at less than 5%.

Motor and sensory MP and LP, the mean, standard deviation of subjects age, RMS, SEM, SSD, CV all parameters of both side were analyzed. Descriptive statistics and inferential statistical analysis has been carried out in the present study.

The present study revealed a mean age of male and female was respectively 49 ± 5.63 and 50.1 ± 4.94. The mean ± SD of CMAP of LP and MP respectively, right (52.55±4), left (48.33±3.38) and right (52.55±4), left (51.06±4.15). The mean ± SD of SAP of LP and MP respectively, right (50.23±5.85), left (48.06±5.46) and right (50.23±5.85), left (48.3±5.04). This results shows no significance change in NCV of MP &LP. All the subjects comes into the range of NCV values.

Out of 50 subjects, each side of CMAP and SNAP of medial plantar nerve, were recorded and comes into range of NCV but CMAP of LP nerve in [M=2(6.45%)] and SNAP of LP nerve in [M=19(68.24%), F=13(61.29%) were not recorded.

Single factor ANOVA test for sensory NCV results shows that there were significant differences in sensory nap amplitude and velocity values of left lateral plantar nerve of male (p=0.0001) , female (p=2.38e-06) and right lateral plantar nerve of male (p= 0.03), female (p=0.04).

Single factor ANOVA test for motor NCV Provides average, variance and p-value of medial plantar motor and lateral plantar motor values correlated to duration of DM-2, the results showed that there were not any significant difference in motor NAP amplitude and velocity values of left lateral plantar nerve of male(p=0.23), female(p=0.38) and right lateral plantar nerve of male (p= 0.33), female(p=00.89) and left medial plantar nerve of male(p=0.12), female(p=0.09) and right medial plantar nerve of male(p=0.33), female(p=00.89).

Provides the conduction velocity of MP and LP nerve. The mean ± SD of CMAP of LP and MP respectively, right (52.55±4), left (48.33±3.38) and right (52.55±4), left (51.06±4.15). The mean ± SD of SAP of LP and MP respectively, right (50.23±5.85), left (48.06±5.46) and right (50.23±5.85), left (48.3±5.04).

DISCUSSION

The objective of this cross sectional study was to explore whether medial plantar nerve and lateral plantar nerve conduction velocity can predict the diabetic foot among diabetic population.

The results states that the motor action potential of both right and left medial & lateral plantar nerve showed normal compound motor action potential (CMAP) which indicated no affect on these nerve in the subjects who were coming under the 0-2 years diagnosed diabetics. In SNAP of right & left medial and lateral nerve showed variation which was not statistically significant specially in left SNAP which showed decreased conduction velocity but could not prove the significance. This can be because n=32 subjects out of n=50 subjects (n=13 F, n=19 M) sensory nerve conduction velocity was not able to be recorded due to some unknown reasons and also due to artefact. The present study states that there is no significance difference in (Rt) & (Lt) side of lateral plantar and medial plantar nerve with a p-value 0.03.

The present study also shows that subjects were having normal nerve conduction in motor NCV in both male and female groups with CV being 6.88 in males and 6.76 in female LPNL and 6.76 in male and 8.25 in female respectively LPNR. There was decrease in RMS value of sensory NCV of 39.69 in male & 38.66 in female LPNL, which showed reduction in the conduction velocity in left lateral plantar nerve sensory conduction though it was not statistically significant change. The decrease in sensory nerve conduction velocity might be due to type-II diabetic patients, possibly initial neuropathic

abnormality and usually exist at diagnosis. Subsequently reducing nerve conduction velocity mostly advances at a stable rate of nearly 1 meter/second/Annum. [26]

Halil Ay, YilmazInanç et al conducted a study on 35 subjects with diabetes and proved 40% neuro physiologically diagnosed with Peripheral Neuropathy had normal conventional nerve conduction velocity of Medial Plantar nerve with 50.81±3.12 m/sec, lower limit of 44 m/sec and 14 subjects had a Medial Plantar nerve NCV less than 44 m/ sec.[27] NidhiYadav, Anjali Shete et al showed that both sensory and motor nerve conduction are useful modality for detecting diabetic neuropathy in subclinical diabetics that Indicates that asymptomatic patients do occur; hence periodic screening should be carried out in diabetics to reduce long term complications like diabetic foot ulceration, etc.[28]

According to Yasar Altun, Ahmet Dermirkol.et al. specific and sensitive response in bilateral medial dorsal cutaneous nerve and medial plantar NCS was obvious than sural Nerve conduction. [29] This finding support the current studies findings that no significant changes in medial plantar nerve, motor conduction and sensory conduction but except than left side lateral plantar sensory nerve shows some changes in Sensory nerve action potential (SNAP) which was not statistically significant. The results might have being influenced as N=32 subjects SNAP was not recorded due to unknown reasons. Sensory examination like pin prick and superficial were not assessed future studies should incorporate sensory examination.

The study sample were very small to generalize and further studies should include more number of subjects Availability of patients for the test was also a concern during the study and temperature changes can also reflect on the results obtained. Hence this study could not predict the diabetic foot among the subjects diagnosed with type-2 diabetes mellitus 0-2 years through medial plantar nerve and lateral plantar nerve conduction velocity.

CONCLUSION

Thus, current study conclude that medial plantar nerve and lateral plantar nerve conduction velocity of motor and sensory NCV may not predict the diabetic foot among diabetic population (n=50). There was no significant changes in medial plantar nerve, motor and sensory but except than left side lateral plantar sensory nerve shows some changes in sensory nerve action potential (SNAP) which was not statistically significant.

CONFLICT OF INTEREST:

The authors declared no conflict of interest.

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