Sensory Nerve Conduction Studies In Non-Insulin Dependent Diabetes Mellitus (NIDDM) Patients Without Symptoms Of Peripheral Neuropathy And Healthy Volunteers: A Comparative Study

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Abstract: Background: NIDDM is one of the chronic diseases all over the world. Prevalence and incidence is highest in Asian countries. Diabetic Neuropathy is one of the commonest long term complications of NIDDM Electro diagnostic tests can be used to detect diabetic neuropathy at an early stage (before development of the signs or symptoms of neuropathy). Nerve conduction study (NCV) is considered to be the most sensitive reliable noninvasive and objective means of investigations of diabetic polyneuropathy. Diabetic neuropathy is curable, and hence if detected, the proper treatment can be instituted in early stages, which again, can give rise to good outcome. As the peripheral nerve has the ability to regenerate, line of treatment can be planned. Aim & Objective: To use recent advancement of technology as a means of assessing the functional status of sensory fiber with particular emphasis upon the correlation between non-insulin dependent diabetes mellitus (NIDDM) and the degree of Neuropathy. Method: 50 diabetic & 50 non diabetic controls of comparable age & BMI were selected. Sensory nerve conduction velocity was measured by orthodromic stimulation with the help of the EMG-NCV recording machine, Neuroperfect plus of Medicaid systems. Result: Out of 50 randomly selected Diabetics, 20 cases showed attenuation of amplitude and slowing of conduction velocity. It suggests 40 percent of total cases are having Neuropathy. Conclusion: Nerve conduction studies can diagnose Diabetic Neuropathy at a very early stage even before symptoms & signs set in. Hence, NCS being simple, harmless, non-invasive and objective technique along with easy interpretation of results can be used routinely to obtain considerable information and evaluate the status of nerves in patients with NIDDM.

Key Words: Diabetic neuropathy, Sensory nerve conduction velocity, Nerve conduction study.

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Introduction: NIDDM is one of the chronic diseases all over the world. Prevalence and incidence is highest in Asian countries. Diabetic Neuropathy is one of the commonest long term complications of NIDDM. To examine the sensory nerves , proper clinical examination of sensory system & nerve biopsy & Electro diagnostic tests can be used to detect diabetic neuropathy at an early stage (before development of the signs & symptoms of neuropathy).Nerve conduction studies (NCS) are considered to be the most sensitive reliable non-invasive and objective means of investigations of diabetic polyneuropathy. It helps in evaluating the type & degree of abnormalities of the peripheral nerves. Specially demyelination diseases & focal compression of nerves. A decrease in amplitude in compound action potential (sum of all individual nerve action potentials) provides evidence of a reduction in the overall number of functioning axons .Slowing of conduction velocity is suggestive of peripheral nerve demyelination which may be diffuse as seen in demyelinating peripheral neuropathy or focal as in conduction block or pressure palsies.NCS can differentiate between focal or diffuse & whether damage is principally axonal or demyelinating.[1]

It establishes diagnosis quiet early than other diagnostic procedures because of its sensitivity to detect slowing of conduction of action potential in a nerve, which is an early indicator of peripheral neuropathy. Neurophysiologic studies supplemented the clinical examination by precisely localizing the lesion and characterizing the conduction abnormalities providing additional information, details and objectivity. They delineate a variety of conditions that may otherwise escape detection.[2]

Non-insulin dependent diabetes mellitus (NIDDM) is a generalized metabolic disorder usually developing with hereditary predisposition. Diabetes can manifest at any time of life but is more common after age of 40 years. Neuropathy is one of the complications of diabetes. 15 percent of patients with NIDDM have both symptoms and

signs of neuropathy but nearly 50 percent have either neuropathic symptoms or slowing of Nerve Conduction Velocity, before patient develops any sign[2,3] Electromyography and Nerve Conduction Studies are the chief investigations for the detection of Peripheral Neuropathy. Evaluation of several parameters including latency, conduction velocity & amplitude is helpful in determining the types of fibre involvement. Mostly NCV determination is used compared to EMG for purpose of studying diabetic neuropathy due to following advantages:

1. It is easily obtainable.
2. It is painless and harmless.
3. It provides a good recording.
4. It is easily reproducible and sensitive.
5. It gives a clear recording with minimal disturbances.
6. Not much of amplification is required.
7. Early functional impairment of nerve in asymptomatic cases can be studied i.e. disorder affecting the nerves insufficient to produce clinical abnormality may be detected as decrease in Sensory NCV.
8. Useful as a tool of diagnostic, prognostic and follow up study of Neuropathy.[4]

Both motor & sensory nerves can be tested in NCS but sensory nerves are affected earlier than motor nerves. Orthodromic&antidromic stimulation give similar results but in antidromic result can be both due to stimulation of sensory & motor fibers so orthodromic should be preferred to have pure sensory NCS. Loss of myelinatedfibers is the most prominent finding in the systemic neuropathy. Segmental demyelination and remyelination of remaining axons are seen in teased preparations. Unmyelinated fibres are also reduced in specimens. Under electron microscope, the basement membranes of intraneral capillaries are seen to be thickened and duplicated.[5]

Diabetic Neuropathy, in all of its varied forms, is the most common peripheral neuropathy associated with a particular disease. Diabetic Neuropathy is a curable and hence if detected early, the proper treatment can be instituted in early stages (i.e. before the development of clinical signs & symptoms), which again, can give rise to good outcome. Not only that, in severe or well advanced cases, the treatment can promote myelination and even promote axonal regeneration, which can offer partial relief[6].

The clinical applicability of Nerve Conduction Study was greatly advanced in 1948, when Hodes et al published their studies of a series of normal subjects and patients with peripheral nerve injury and hysterical paralysis. Although nerve action potentials are of much smaller amplitude than muscle potentials, they can be recorded quite readily if suitable electrodes are placed on the skin overlying the nerve. In clinical practice, both antidromic & orthodromic Method provide the same information. Also either sensory or motor nerves can be used.

The drawbacks of the sensory nerve conduction study are that: only the status of distal nerves can be evaluated. Only the velocities in the large fiber can be measured. These draw backs do not pose any serious problem, since in NIDDM, distal nerves with largest myelinated 'A' fibers are chiefly affected. The difference in reduction of SNCV of lower limbs is greater than that in upper limbs, showing that long nerves are comparatively more affected.[7] Conduction abnormalities develop diffusely along the entire length of nerve but more in distal than the proximal segment. Proximal conduction delay is also seen suggesting radiculopathy.[8]

Aim & Objective: To assess the functional status of sensory nerve fiber, with particular emphasis upon the correlation between NIDDM and the degree of Neuropathy.And asses the alteration in the Sensory Nerve Conduction Velocity in Diabetics as compared to controls.

Method: Permission was taken through proper channel concerned hospital authorities.50 diabetic patients without signs & symptoms of neuropathy above 30 yrs of age compared with 50 age & sex matched healthy volunteers. Written informed consent was taken. Performa was used to record personal data, state of diabetes control & ongoing treatment.Other causes of neuropathy ere ruled out by asking & seeing their reports. Then sensory system was thoroughly examined followed by

recording sensory nerve action potential by EMG-NCV recording machine, Neuroperfect plus of Medicaid systems. Skin surface is cleaned with spirit before placing the electrode using conductive jelly placed the electrodes.4 electrodes were used. Electrical stimulator (stimulating electrode), & 3 recording electrode (active, reference &grounding) for recording potential changes. These electrodes are connected through preamplifier to the cathode ray oscilloscope (C.R.O.). We gave supramaximal stimulation with the help of stimulating electrodes & recorded action potential .We used sensory nerve to record the conduction velocity. Orthodromic conduction measured in which nerve is stimulated at a distal point & action potential is recorded proximally.

For ulnar nerve: - Place silver ring electrode (stimulating) one on the middle phalanx & other on the terminal phalanx. Apply 2 silver cup recoding electrodes about 2-3cms apart proximal to wrist skin crease. Apply ground electrode between stimulating & recording electrode on the palm.
For median nerve:-The surface recording electrode was placed 3 cm proximal to the distal wrist crease and reference is placed at a distance of 3 cm proximally. For stimulating electrodes were placed at the second or third digits. Radial SNCV is commonly carried out in Superficial Radial Nerve. The stimulating electrode is placed in first web space and reference 3 cm distal. The recording electrode is placed 10-14 cm proximal to recording electrode at the lateral edge of radius. Superficial peroneal nerve:-Recording electrode is 10-15 cm proximal to the upper edge of lateral malleolus anterior to peroneus longus.

Sural nerve:-The surface electrode between lateral malleolus and tendoachilles was used to stimulate Sural Nerve & the recording electrode, distal to lower border of gastrocnemius at the junction of middle and lower third of leg. During the recording, the leg was kept relaxed and in lateral position that was convenient.

In all the nerves grounding electrode was kept between stimulating & recording electrode. Amplitude is noted, conduction velocity (mt/sec) is calculated using distance between stimulating & recording electrode (mm) & onset of latency (msec).

This was done in 5 nerves of upper & lower limb
In upper limb:-Median Nerve, Radial Nerve, Ulnar Nerve
In lower limb:-Superficial Peroneal Nerve, Sural Nerve.

Result & Discussion: Majority of cases lie above 50 years of age. Hence comparable healthy volunteer groups with majority people from above 50 years of age were chosen.

Table 1: Distribution of Cases & control According to Age

Sr. No.	Age Range (in yrs.)	No of Cases			No of controls		
		M	F	% of total cases	M	F	% of total controls
1	30-40	2	1	6%	6	2	16%
2	41-50	8	2	20%	7	1	16%
3	51-60	25	1	52%	13	5	36%
4	>60	9	2	22%	9	7	32%

Table 2: Differences in Sensory Nerve Conduction Velocities with Duration of Diabetes

Sr. No.	Sensory Nerve Affected	Duration of Diabetes & SNCV (in m/s)		
		<5yrs.	5-10yrs.	>10yrs.
1	Median Nerve	52.1	45.2	40.2
2	Radial Nerve	52.6	42.2	41.2
3	Ulnar Nerve	50.2	47.8	47.2
4	Superficial Peroneal Nerve	47.2	40.2	25.6
5	Sural Nerve	46.2	42.2	40.2

It is evident that with the increase in duration of diabetes conduction velocity decreases. This finding is comparable with study done in zahedali et al[7].

Table 3 shows 'p' Values are less than the level of significance of our study i.e. 0.05 , it can be concluded that there is significant decrease in Amplitude and conduction velocity of almost all sensory nerves in asymptomatic Diabetics as

compared to healthy volunteers. This finding is comparable to finding in study done by Zahedali et al7 and other study done by P Noel found the sensory nerve conduction velocity reduced compared to the control group.[8]

As the data was not normally distributed so non-parametric test (MANN-WHITNEY TEST) has been applied. In comparison to normal healthy volunteers, amplitude and conduction velocity range is significantly decreased in NIDDM cases in almost all the sensory nerves.

Table 3: Comparison of Sensory Nerve Conduction Studies:-Amp (in microvolts) & CV (in m/s), in Asymptomatic Diabetics and Healthy Volunteers in our Study

Sr.No.	Sensory Nerves Affected	SNCV	Controls (Mean±SD)	Cases (Mean±SD)	'p' Value
1	Median N	Amp	36.8±5.4	30.1±8.3	0.002
		CV	54.7±2.4	52.1±3.8	0.001
2	Radial N	Amp	14.7±9.6	9.1±4.6	0.003
		CV	55.5±2.5	53.3±4.3	0.008
3	Ulnar N	Amp	33.9±5.6	27.9±6.7	0.001
		CV	54.2±3.3	51.9±3.4	0.009
4	Superficial Peroneal N	Amp	3.6±1.5	2.7±0.7	0.002
		CV	48.7±1.4	45.2±4.7	0.001
5	Sural N	Amp	15.8±4.0	10.3±4.4	0.003
		CV	50.6±1.9	46.8±3.5	0.002

Table 4: Differences in Sensory Nerve Conduction Velocities: Amp (in microvolts) & CV (in m/s), according to Status of Diabetes Control

Sr. No.	Sensory Nerves Affected	SNCV	Poorly Controlled Diabetes (Mean±SD)	Well Controlled Diabetes (Mean±SD)	Mann Whitney test	'p' Value
1	Median N	Amp	22.5±6.2	33.9±6.4	61.5	<0.05
		CV	49.2±3.7	53.6±2.9	95.5	<0.05
2	Radial N	Amp	6.1±2.1	10.6±4.8	102.0	<0.05
		CV	50.6±3.4	54.7±4.0	111.5	<0.05
3	Ulnar N	Amp	22.5±5.7	30.8±5.3	89.5	<0.05
		CV	49.2±3.0	53.4±2.7	69.0	<0.05
4	Superficial Peroneal N	Amp	2.3±0.5	2.9±0.7	149.0	<0.05
		CV	41.5±4.6	47.3±3.3	63.0	<0.05
5	Sural N	Amp	7.5±1.7	11.7±4.7	87.0	<0.05
		CV	44.5±2.5	47.8±3.4	137.0	<0.05

Table 4 shows:-As 'p' Values are less than the level of significance of our study i.e. 0.05 , it can be concluded that there is significant decrease in Amplitude and conduction velocity of almost all sensory nerves in asymptomatic Diabetics as compared to healthy volunteers.

Sensory Nerve Conduction Velocity is lower in poorly controlled Diabetes in comparison with well controlled NIDDM. Diabetic status of the cases were decided by the level of fasting blood sugar & HbA1c.As the data was not normally distributed so non-parametric test (MANN-WHITNEY TEST) has been applied. 'p' Value is <0.05, which shows the difference is highly significant. So SNCV depends upon severity of NIDDM. This correlates with the observation of swaroop et al.[9] But study done by Lamontagne A, says that degree of electrophysiological involvement is same whether diabetes is well or poorly controlled.[10] As NIDDM is more severe and poorly controlled (seen by FBS, PPBS & Hb1Ac of last month that was not within normal limits), the NCV is significantly reduced.

Table 5: Distribution of Cases According to Affected Nerve

Sr. No.	Nerve Affected	No. of Cases	% of Cases
1	Median Nerve	19	38%
2	Radial Nerve	13	26%
3	Ulnar Nerve	11	22%
4	Peroneal Nerve	24	48%
5	Sural Nerve	26	52%

Most common nerve affected in upper limb is Median Nerve while in lower limb is sural nerve. It is comparable with study done by Zahed Ali et al, in which they found nerves of lower limb are more affected than upper limb and also found that sural& median are commonly affected [7].

Conclusion: As compared to healthy volunteers, asymptomatic diabetic patients show significant decrease in SNCV Studies. There is significant reduction in amplitude and conduction velocity of all the sensory nerves in asymptomatic diabetic patients as compared to healthy volunteers. Most commonly affected nerves are Median Nerve in upper limb and Superficial Peroneal in lower limb. As the duration of NIDDM increases, the Sensory Nerve Conduction Velocity decreases. If NIDDM is under control, then SNCV is slightly reduced. In poorly controlled NIDDM, SNCV is markedly reduced. NIDDM is one of the chronic diseases all over the world. Prevalence and incidence of NIDDM is highest in Asian countries. Diabetic Neuropathy is one of the commonest long term complications of NIDDM. In spite of the fact that Diabetes is more prevalent in higher income groups, higher rates of Neuropathy are seen in lower income groups, may be due to associated nutrient deficiencies. NCV studies can diagnose Diabetic Neuropathy at a very early stage even before clinical signs sets in. Hence, NCV being simple, harmless, non-invasive and objective technique along with easy interpretation of results can be used routinely to obtain considerable information and evaluate the status of nerves in patients with NIDDM. Nerve conduction studies may be effectively used to select the most beneficial therapy.Establishment of such Electro-diagnostic techniques in Department of Physiology can be recommended to bring new direction and new opportunities to the subject with concept of CLINICAL-NEUROPHYSIOLOGY.

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