Original Article

Nerve Conduction Study in Patients with Type 1 Diabetes

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Abstract

The present cross-sectional case control study was carried out with the aim to study Nerve conduction in patients with Type 1DM & compare the results between type 1 diabetics & control group.

Methodology

Fifty diagnosed cases (21 females and 29 males of type 1 DM were registered in the study. Equal number of controls 50 (24 females and 26 males) were also recruited in the study. Nerve conduction was performed on following nerves:1.Median Motor (Right and Left) of upper extremity.2Right and Left Peroneal Nerve of Lower extremity.3Median Sensory and Sural (Sensory nerve of lower extremity).From history and clinical examination following observations were obtained.

Results

Mean age of patients was 23.58=6.27. Mean duration of diabetes 7.3+3.99 years.Neurological signs and symptoms positive were weakness of muscle 10%, paraesthesia 6%, Impaired of sense of vibration in 2%. Control group was asymptomatic. Reduction in conduction velocity and amplitude was seen in cases as compared with controls and increase in latency was observed in cases not in controls with negative correlation of conduction velocity with duration of diabetes.

Motor Conduction: Significant increase in latency (ms) in median and peroneal. Amplitude was decreased in 42% of cases in median nerve and 32% peroneal nerve. Significant decrease in amplitude in both median and peroneal nerves Decreased CV 62% & 42% of cases respectively in median and peroneal nerves. Sensory conduction: 74% had decreased sural nerve CV, 22% had increased latency and 10% had decreased amplitude. In median sensory, 6% had decreased amplitude and 14% increased latency

Conclusions

Reduction in conduction velocity and amplitude and increase in latency correlated positively with duration of diabetes.

Key Terms: Type 1 Diabetes, nerve conduction, neuropathy

Introduction :

In recent years, Diabetes Mellitus (DM) has assumed a pandemic proportion. It has been stated that nearly 200 million people will be affected by this disease all over the world, in next 10- 15 years. Of these about 55 millions are going to be Indians. Thus India has already become diabetic capital of the world.

About 10% of the total patients suffering from diabetes mellitus(DM) are the patients of type-I DM (here considered to be synonymous with IDDM), which is known to have autoimmune origin, since long. Development of autoimmunity in these patients leads to destruction of β cells of islets of pancreas resulting in diabetes which is primarily T-lymphocyte mediated. Patients with long standing diabetes suffer from different complications. Of them neuropathy is a very common complication. At least in type II DM, it is a common cause of morbidity and long lasting suffering which is very difficult to cure. Different studies have reported this complication and altered nerve conduction in patients with type I DM also. Thus, in this study, we wanted to assess the nerve functioning of the patients with type -1DM, by doing nerve conduction studies. This will help to find out those

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patients who are at higher risk of developing neuropathy in future, though presently asymptomatic. This will also help us to know whether nerve conduction study will be of value as a guide for control of diabetes.

Material & Methods:-

It is a cross sectional case control study which involves 50 cases (21 females and 29 males) and fifty age & sex matched controls (24 females and 26 males). Study was aimed at assessing nerve conduction in Type I diabetics, compare the results in cases with controls. Also to find out whether the derangement is more in motor or sensory nerves & correlate it with duration of DM

Selection of subjects:-

Cases included diagnosed patients of type I DM, in the age group of 10 -35 years. Controls were healthy, age, sex and socioeconomic status matched persons. Subjects were recruited from Medicine and Pediatric OPD and also indoor patients from the institution. The procedure was explained to the patients in detail and written consent was obtained. Clearance of Ethics committee, of the institution was sought prior to the beginning of the project.

Diagnosed cases of Type1 DM having more than 3yrs duration receiving regular insulin, equal socioeconomic status, free from psychiatric illness were included. Pregnant & lactating women, autoimmune disorders, exposure to heavy metals, deformed extremities & other causes of neuropathy were excluded . Detailed clinical evaluation was done. Number of attacks of ketoacidosis, medications in last 1 year, number of insulin injections per day was noted in detail.

On physical examination weight & height was measured. Systemic examination was undertaken for signs of neuropathy and other complications of DM. Sensory and motor examination of central nervous system was done in detail including examination of reflexes.

For Nerve Conduction study, parameters selected were: Latency in milliseconds (ms), amplitude (Amp) in micro volts(μV) and conduction velocity(CV) in meters per second (m/s).

Sensory Conduction in upper extremity was done on Median nerve and in lower extremity on Sural nerve. Motor nerve conduction was tested on Median Nerve in upper extremity and on Peroneal Nerve in lower extremity.

Nerve Conduction Study

Room temperatures were recorded in ^{0}C . Nerve Conduction Study was done by using RMS EMG. EP Mark II by Recorders and Medicare Systems ISO 9001.

Sensitivity: 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, 500, mV/div

Electrical stimulator:

Hand held constant current electrical stimulator with stimulus intensity dial and stimulus trigger on handle and save and start/ stop switches on the handle.

Sensory Nerve Action Potential (SNAP)

It is done by antidromic method. SNAP was tested on Median Nerve in both upper extremities and Sural Nerve in both lower extremities in each patient:

Median Sensory Nerve Action Potential (Median Nerve SNAP)-

Recording electrodes 3cm proximal to distal wrist crease and action potential is recorded distally. The distance between active and recording electrode was measured. If a is onset latency in ms and b is the distance between stimulating and recording electrode in mm then Nerve Conduction Velocity = b/a meter per second. The filter setting for sensory conduction was 10 Hz -2KHz. Sweep speed 1-2ms/ div and gain 1-5μV /div.In SNAP amplitude is measured from baseline to negative peak.

Sural Nerve SNAP: It is a purely sensory nerve derived from S1 and S2 roots formed by 2 components. Nerve conduction of sural nerve is recorded by surface electrode between lateral malleolus and tendoachillis. The nerve was stimulated 10-16cm proximal to the recording electrode, distal to lower border of gastrocnemius at the junction of middle and lower third of leg. Patients were relaxed and in lateral position.

Motor Nerve Conduction

For motor nerve, compound muscle nerve action potential (CMAP) is recorded. Filter setting is 5 Hz – 10 KHz and sweep speed 5ms/div.If c is the distance between two points, a is distal latency in m/s and b is the proximal latency, then conduction velocity = c/b-a in m/s.Amplitude is recorded in micro volts (μV) and latency in milliseconds (ms)

Median Motor Nerve Conduction

Study. Recording electrode was placed close to the motor point of abductor pollicis brevis and reference electrode 3 cm distal, at first metacarpophalangeal joint. Supramaximal stimulation was given at wrist (3cm proximal to distal wrist crease), then at elbow near the volar crease of brachial plexus and in axilla.

Peroneal Nerve Conduction-Surface recordings are obtained from Extensor Digitorum Brevis. Stimulation is given at ankle and 2cm distal to fibular neck.

Statistical Analysis:

Continuous variables in baseline characteristics are represented in mean ± S.D. Nerve conduction was

compared between cases and controls by student's t test, categorical variables are expressed in percentages.

$p < 0.05$ was taken as statistically significant. Data was analyzed on statistical software inter cooled stata version 8.0.

Results

The mean duration of diabetes in the cases was 7.86 ± 4.69 years in males and 6.52 ± 2.69 years in females All the vital parameters in both cases and controls are comparable with no significant difference in these characteristics. **(Table1).** On neurological assessment only 11 cases had neurological symptoms & signs. Remaining 39 cases neither had neurological symptoms nor signs**.(Table2)** Nerve conduction latency of median motor nerve at wrist, elbow and axilla was more in cases as compared with control group(p value of 0.0000) which is highly significant .Increased latency and reduced amplitude was also observed in peroneal nerve as compared with controls which was statistically highly significant..Amplitude of median motor nerve conduction, was significantly reduced in cases as compared with controls (p = 0.0000 H.S.). **(Table 3).** Median motor nerve and peroneal conduction velocity was significantly reduced in cases in both segments. (**Table No.4).** The most commonly affected nerve is median motors 42% followed by peroneal 32% whereas percentage of affected in Median Sensory and Sural is 6% & 10% respectively. Control group did not have decreased amplitude in any of the nerves tested.Increased latency was observed in 72% of cases in motor conduction and 22% in sensory conduction. In cases increased latency was seen in 4% of controls with a p value of 0.0000. statistically significant.

Statistically significant reduction in sensory nerve conduction(Median& Sural nerves) was observed in cases as compared to controls.(**Table5)** .

Sural appears to be most commonly involved nerve with74% type 1 diabetics showing decreased conduction velocity, followed by median motor conduction velocity, median motor conduction in 62% cases and 42% had reduced peroneal conduction.

Reduction in conduction velocity and amplitude correlated negatively with duration of diabetes and increase in latency correlated positively with duration of diabetes. **Fig. 1**

Discussion

Peripheral neuropathy is the commonest among long term complications of diabetes. Its prevalence varies depending on the population studied and criteria adopted for diagnosis. Electrophysiological abnormalities can be demonstrated in 80% of the diabetics. Factors like age, severity of diabetes, associated malnutrition, alcoholism and micro vascular diseases modify the rate of prevalence.[1]

Neuropathy in diabetes mellitus is multifactorial. Major emphasis has been placed on polyol pathway though many other theories have been put forward. Polyol pathway, advanced glycation end products, altered neurotrophic support theory and impaired C- peptide action are the various possible mechanisms that affect nerve functioning in diabetics [2,3,4,5.]

In the present study, it was found that all the parameters i.e. amplitude and conduction velocity were significantly reduced in motor as well as sensory nerves of upper and lower extremities in cases as compared with controls whereas latency was seen to be more in cases. Our study revealed that 80% of the patients had at least one abnormal finding in nerve conduction.

The adult levels of nerve conduction are attained by the age of 3-5 years, when myelination is complete. The conduction velocities begin to decline after 40 years of age. As the age group in our study is between $23.58 + 6.27$ years and control group is age matched effect of age on nerve conduction, is ruled out.

Duration**:** In our study mean duration of disease is7.3 +3.99 years. The correlation of duration with deranged nerve conduction is highly significant. Both motor and sensory conduction studies and all the parameters viz. latency, amplitude and conduction velocity are significantly affected with increasing duration of diabetes showing increase in latency and decreases in amplitude and conduction velocity [6]

Results of the present study correlated well with other studies which reported prevalence of peripheral neuropathy 62% & 49% respectively in type I Diabetics & impaired peroneal nerve conduction[7,8].The percentage of abnormal electrophysiological parameters in different motor and sensory nerves inType1 Diabetics were: 83.3% in peroneal nerve, 73.3% in posterior tibial nerve as reported by Karasidag S et al [9.]

Previous literature reports revealed that occurrence of diabetic sensory-motor ployneuropathy is directly related to duration of DM & glycemic control [10]. The present study also observed that conduction velocity and amplitude correlated negatively with duration of diabetes and increase in latency correlated positively with duration of diabetes.

There is evidence from several laboratories of an increased prevalence of circulating immunocomplexes (CIC) in diabetic patients. It was been suggested that CIC are pathologically related to chronic diabetic complications. Fierro B et al in his study observed that there was greater

slowing of median motor and sensory and tibial sensory conduction velocities in patients with CIC with respect to the patients without CIC, suggesting a possible role of immunological factors in pathogenesis of diabetic neuropathy in type 1diabetics [11]. The present study was not aimed at estimating circulating immune complexes though this could be the contributing factor for development of neurological abnormalities.

Kitano Y et al examined acute effects of glycaemic control on axonal excitability in human diabetics and concluded that in diabetic nerves, the activation of polyol pathway, and a resulting decrease in Na+ -K+ ATPase activity leads to intra axonal Na+ accumulation and a smaller Na+ gradient across axolemma than normal during hyperglycemia and its restoration by glycaemic control in diabetic patients [12]. Thus multiple pathophysiological mechanisms seem to be involved in development of neurological complications.

In a follow up study, done at Toronto, there were asymptomatic 246 (60%) prevalent cases of type1 diabetes with abnormal electrophysiological findings.25 (23%) cases of them became symptomatic incident DSP (Diabetic Sensory Polyneuropathy) after 3.9 years mean follow-up [13] . Follow up was not the aim of the present study.

Individual NCS parameters or their simple combinations are valid measures for identification and future prediction of DSP. Further research into the predictive roles of tibial F-wave latencies, peroneal conduction velocity, and sum of conduction velocities as markers of incipient nerve injury is needed to risk-stratify individuals for clinical and research protocols [13].

Conclusions

So we conclude sural sensory nerve is the most commonly affected nerve in type 1 DM. Even in the absence of signs and symptoms abnormal findings in NCV studies are common in type 1 DM & full blown clinical neuropathy can be a major cause of morbidity in type 1 DM patients. Hence screening for NCV should be undertaken routinely before neuropathy becomes irreversible. Electro-physiological studies help in early diagnosis of neuropathy before the appearance of clinical symptoms of this complication.

Table No.1 Vital statistics in cases and controls

	Cases n =50			Control n=50		
	Total 50	**M(29)**	**F(21)**	**Total 50**	**M(26)**	**F(24)**
Age in yrs.	23.58±6.27	24.55 ± 6.42	22.24± 5.49	23.42±6.23	24.28± 6.12	22.37± 6.39
Height in cm	155.55± 11.43	159 .89 ± 11.05	147 .95 ± 10.52	156.89 ± 11.46	165.07 ± 4.30	147.83 ± 9.93
Weight in kg	49.3 ± 9.07	53.55 ± 7.88	43.42 ± 7.06	52.88 ± 9.14	57.92± 7.5	47.41± 7.51
BMI in kg/m2	20.13±2.05	20.39±1.67	19.76±2.38	20.84±2.08	21.16±2.3	20.49±1.80
Duration of DM in completed years	7.3 ± 3.99	7.86±4.69	6.52 ±2.69			

Table No.2Distribution of cases according to Neurological findings (N=50).

Neurological Signs and Symptoms	No.of cases	%
Weakness of Muscle or group of muscles	05	10%
Paraesthesia /pain / Cramps / burning	03	6%
Loss of touch Sensation	-	-
Loss of sense of superficial pain	-	-
Impairment of vibration sense	01	2%
Impairment of kinesthetic sensation	-	-
	02	4%

Table No.3 Median (wrist, elbow, axilla) and Peroneal (ankle, knee) Motor Conduction

	Mean Latency in ms ± S.D.			Mean Amplitude in µv ± S.D.		
	Cases n = 50	**Control n = 50**	**p value**	**Cases n = 50**	**Control n = 50**	**p value n = 50**
Wrist	2.46 ± 0.59	2.48 ± 0.54	0.9296 NS	5.89 ± 2.93	8.52 ± 1.68	0.0000 HS
Elbow	7.52 ± 1.23	6.13 ± 0.54	0.0000 HS	5.86 ± 3.2	8.63 ± 1.7	0.000 HS
Axilla	11.43 ± 2.21	8.49 ± 0.74	0.0000 HS	5.47 ± 3.45	8.76 ± 1.89	0.0000 HS
Ankle	2.87 ± 0.73	2.83 ± 0.49	0.7928 NS	4.31 ± 1.56	5.99 ± 1.14	0.0000 HS
Knee	11.48 ± 1.61	9.45 ± 0.62	0.0000 H.S	4.07 ± 1.43	6.11 ± 1.32	0.0000 HS

HS = Statistically highly significant

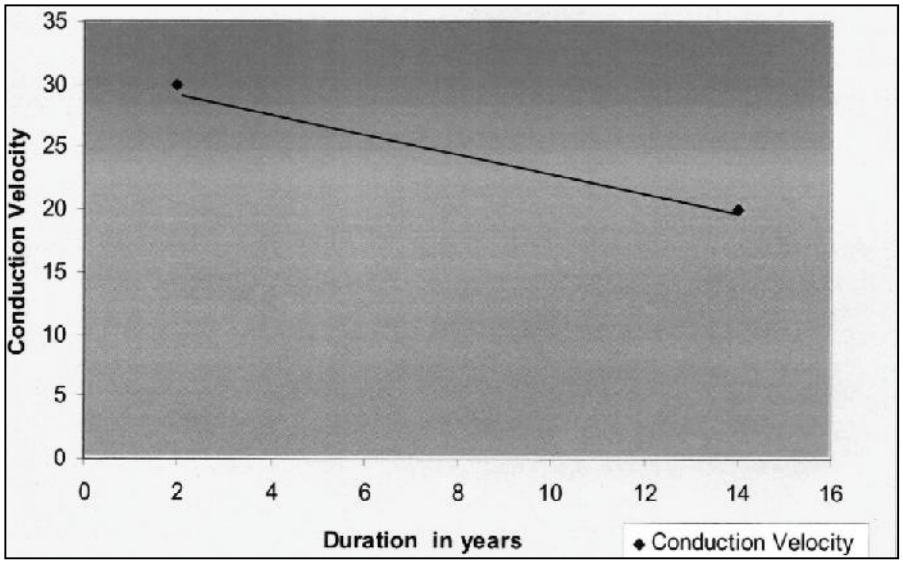
Table No.4Conduction Velocity in Median Motor and Peroneal Nerves

	Mean Conduction Velocity in m/s S.D.		
	Median Motor		**Peroneal**
	Wrist - Elbow	**Elbow-Auxilla**	**Ankle-Knee**
Cases	49.19 ± 8.27	52.47 ± 11.86	41.27 ± 5.91
Control	63.08 ± 3.06	63.81 ± 3.46	59.22 ± 3.81
p value	0.0000 HS	0.0000 HS	0.0000 HS

Table No 5. Sensory Nerve Conduction : Median and Sural Nerves.

	Mean Latency (in ms) ±S.D.		**Mean Amplitude (in µV) ±S.D.**		**Mean Conduction Velocity in m/s**	
	Cases	Controls	Cases	Control	Cases	Control
Median	2.92±0.96	2.45±0.71	26.34±11.98	39.72±7.51	47.91±10.03	60.45±9.39
P value	0.0068 HS		0.0000 HS		0.0000 HS	
Sural	3.8±0.88	3.14 ±0.63	22.06±27.75 Median 16.5	28.38±5.07	35.00±7.74	57.29± 9.77
P value	0.0000 HS		0.0000 HS		0.0000 HS	

Fig. 1 : Negative Co-relation of Duration of Diabetes with Conduct Velocity of Sural Nerve.



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