A Study to Evaluate Changes in Nerve Conduction Velocity (NCV) to Glycemic Control in Diabetic Neuropathy Patients in Type 2 DM at Tertiary Care Hospital in Kolkata

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ABSTRACT

Diabetic neuropathy is one of the most important complications of type 2 diabetes mellitus. But whether the glycaemic variability is related with the diabetic neuropathy is not proven with sufficient data yet. So, this study is aimed at determining the association between the glycaemic variability with the diabetic neuropathy. Fifty patients (32 males and 18 females; aged (yr) 58.32 ± 9.629 (mean ± SD)) were investigated for this study. Glycaemic variability is estimated by HbA1c measurement and neuropathy is quantitatively evaluated by Nerve Conduction Velocity (NCV) of median nerve for sensory and motor component. HbA1c had a significant association with the NCV. In patients in whom HbA1c value improves both right and left sided motor and sensory NCV increased which is statistically significant ($P<0.05$). In patients in whom HbA1c value deteriorates both sided median nerve motor and sensory NCV decreased, but the left sided reduction in NCV is statistically significant ($P<0.05$) but in right side reduction in motor and sensory NCV is statistically insignificant ($P>0.05$). So, we may conclude that glycaemic variability could be a risk factor. This study addresses one of the key issues related to the evaluation of diabetic neuropathy.

KEYWORDS
Diabetes mellitus, Diabetic neuropathy, Nerve conduction velocity, HbA1c

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INTRODUCTION

Diabetes Mellitus (DM) is one of the four main types of non-communicable diseases.[1] It is a common metabolic disorder characterized by the hyperglycemia due to reduced insulin secretion, reduced glucose utilization and increased glucose production. DM causes significant pathophysiologic changes in multiple organ system leading to complications causing immense suffering to the patient imposing tremendous financial burden to the patient as well as on the health care system. Due to increasing incidence DM has become a leading cause of morbidity and mortality in the world.[2] The cost per person with DM (in USD) is 95 in India.[3]

Among many long term complications of DM, Diabetic neuropathy is one of them and arises in about 50% of patients suffering from long standing type 1 and type 2 DM. This may be a mono neuropathy, poly neuropathy or autonomic neuropathy. As per American Diabetic Association (ADA) an internationally agreed simple definition of Diabetic Peripheral Neuropathy (DPN) for clinical practice is "the presence of symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after the exclusion of other causes".

The commonest form of diabetic neuropathy is the Distal Symmetric Polyneuropathy (DSPN)[4,5] which is characterized by sensory loss beginning in the toes and progressing up the legs as well as fingers and arms. Tingling, burning and pain may also be present.[5] DPN is associated with some modifiable and non-modifiable risk factors such as degree of hyperglycemia, lipid and blood pressure indexes, duration of DM and height. DPN is less consistently associated with alcohol consumption and cigarette smoking.[6]

The aim of this study was to evaluate the changes in Nerve Conduction Velocity (NCV) in relation with glycemic control in Type 2 DM patients with symptoms of diabetic neuropathy.[7]

MATERIALS AND METHODS

Patients

Between July 2016 to July 2017, 50 (fifty) type 2 DM patients with symptoms of diabetic neuropathy were evaluated in the Diabetic Clinic and Department of Pharmacology, R.G.Kar Medical College, Kolkata, West Bengal, India. The mean age in years was 58.32 ± 9.629 (Mean ± SD); the male to female ratio was 1.78: 1 (male 32, female 18).[8]

Methods

The study was designed as a prospective observational study. Data were collected using patients' history and treatment sheets, investigations reports and office notes. The following data were collected: Age, sex, glycosylated hemoglobin (HbA1c) values, Nerve Conduction Velocity (NCV) of the patients. The patients were subdivided into 2 groups: Group 1 comprising patients with deteriorating HbA1c and group 2 comprising patients with improving HbA1c. Statistical significance of the results was calculated by paired t test, unpaired t test with $P \leq 0.05$ as significance. Significance is mentioned in the tables and text where relevant.

Age group	No. of patients (n=50) (male 32, female 18)	% of patients	Mean age ± SD	Male:Female
40-44	4	8	58.32 ± 9.629	1.78
45-49	7	14		
50-54	7	14		
55-59	10	20		
60-64	9	18		
65-69	7	14		
70-74	4	8		
≥ 75	2	4		

Table 1. Age Group Distribution.

Male's age in years (n=32)	Female's age in years (n=18)	P value
59.22 ± 8.794 (Mean ± SD)	56.72 ± 11.04 (Mean ± SD)	0.38

Table 2. Comparison of Age of Onset of Neuropathy Between Male and Female.

Group Clarification of Study Population

Patients participating in the present study (n=50), 16 patients showed deterioration in HbA1C value in respect to initial value and 34 patients showed improvement in HbA1C value in respect to initial value after a period of 3 months of follow-up. Those 16 patients in whom HbA1C value deteriorates comprise group 1 (n=16) and 34 patients in whom HbA1C value improved comprise group 2 (n=34) in the study in respect to evaluation and comparison of results.

Group distribution of study population	HbA1C value at beginning	HbA1C value after 3 months	Mean ± SD of differences	95 % CI	Correlation coefficient (r)	P value
Group 1 (n=16)	7.369 ± 0.7209 (Mean ± SD)	7.75 ± 0.7746 (Mean ± SD)	0.3813 ± 0.2482 (Mean ± SD)	0.249 to 0.5135	0.9474	< 0.00001
Group 2 (n=34)	7.976 ± 0.8683 (Mean ± SD)	7.397 ± 0.7013 (Mean ± SD)	-0.7274 to -0.4314	0.8752	0.8752	< 0.00001

Table 3. Comparison of HbA1C Value Between Group 1 *vs.* Group 2.

Group distribution of study population	Pre motor NCV(Rt. median nerve) m/s (at beginning)	Post motor NCV (Rt. median nerve) m/s (after 3 months)	Mean ± SD of differences	95 % CI	Correlation coefficient (r)	P value
Group 1 (n=16)	47.51 ± 2.165 (Mean ± SD)	47.18 ± 2.27 (Mean ± SD)	-0.3281 ± 0.904	-0.8098 to 0.1536	0.918	0.16711
Group 2 (n=34)	46.59 ± 2.432 (Mean ± SD)	47.09 ± 2.216 (Mean ± SD)	0.4997 ± 0.9537	0.167 to 0.8325	0.92	0.00044

Table 4. Comparison Between Motor NCV (Pre V/S Post) of Rt. Median Nerve in Group 1 and Group 2.

Group distribution of study population	Pre sensory NCV (Rt. median wrist) m/s at beginning	Post sensory NCV(Rt. median wrist) m/s after 3 months	Mean ± SD of differences	95% CI	Correlation coefficient (r)	P value
Group 1 (n=16)	49.87 ± 2.137 (Mean ± SD)	49.39 ± 2.349 (Mean ± SD)	-0.4744 ± 1.047	-1.032 to 0.08374	0.8952	0.0901
Group 2 (n=34)	48.82 ± 1.811 (Mean ± SD)	49.62 ± 2.103 (Mean ± SD)	0.8044 ± 1.082	0.4269 to 1.182	0.8575	0.0001

Table 5. Comparison Between Sensory NCV (Pre V/S Post) of Rt. Median Wrist in Group 1 and Group 2 Patients.

Group distribution of study population	Pre motor NCV (Lt. median nerve) m/s at beginning	Post Motor NCV (Lt. median nerve) m/s after 3 months	Mean ± SD of differen ces	95% CI	Correlation coefficient (r)	P value
Group 1 (n=16)	47.63 ± 2.183 (Mean ± SD)	47.11 ± 2.408 (Mean ± SD)	-0.5187 ± 0.6807	-0.8815 to -0.156	0.9607	0.0081
Group 2 (n=34)	46.65 ±2.511 (Mean ± SD)	47.28 ± 2.186 (Mean ± SD)	0.6318 ± 1.083	0.254 to 1.01	0.9028	0.0018

Table 6. Comparison Between Motor NCV (Pre V/S Post) of Lt. Median Nerve in Group 1 and Group 2.

Group distribution of study population	Pre sensory NCV(Lt. median wrist) m/s at beginning	Post sensory NCV(Lt. median wrist) m/s after 3 months	Mean ± SD of differences	95% CI	Correlation coefficient (r)	P value
Group 1 (n=16)	50.12 ± 2.339 (Mean ± SD)	49.55 ± 2.412 (Mean ± SD)	-0.5625 ± 0.8758	-1.029 to -0.09582	0.9325	0.0214
Group 2 (n=34)	49.52 ± 2.536 (Mean ± SD)	50.01 ± 2.221 (Mean ± SD)	0.4912 ± 1.191	0.07571 to 0.9066	0.8829	0.0219

Table 7. Comparison Between Sensory NCV (Pre v/s Post) of Lt. Median Wrist in Group 1 and Group 2 Patients.

RESULTS

Clinical Presentation

Table 1 shows the percentage and number of patients in different age groups: (n=50). The mean age of all participants including male and female is 58.32 ± 9.629 (Mean ± SD). The age group most commonly affected is between 55-59 years (10 out of 50 patients including male and female). Between 50 patients 32 (64%) are male and 18 (36%) are female (Table 1).

Table 2 shows the mean age in male group is 59.22 ± 8.794 (Mean ± SD) and the mean age in female group is 56.72 ±11.04 (Mean ± SD). There is no statistically significant difference in age (as P value is 0.38, unpaired t test applied) between male and female across the group (Table 2).

In Table 3 in group 1 (n=16), the mean HbA1C value at the beginning of study is 7.369 ± 0.7209 (Mean ± SD) and after 3 months of follow-up is 7.75 ± 0.7746 (Mean ± SD). The p value is <0.0001 (paired t test applied), that means deterioration in the HbA1C value after 3 months of follow up is statistically significant (Table 3). Where as in group 2 (n=34), the mean HbA1C value at the beginning of study is 7.976 ± 0.8683 (Mean ± SD) and after 3 months of follow-up is 7.397 ± 0.7013 (Mean ± SD). The p value is <0.0001, means improvement in the value of HbA1C is statistically significant (paired t test applied).

In group 1 (n=16), the mean HbA1C value at the beginning of study is 7.369 ± 0.7209 (Mean ± SD) and after 3 months of follow-up is 7.75 ± 0.7746 (Mean ± SD). The p value is <0.0001 (paired t test applied), that means deterioration in the HbA1C value after 3 months of follow up is statistically significant (Table 3). Where as in group 2 (n=34), the mean HbA1C value at the beginning of study is 7.976 ± 0.8683 (Mean ± SD) and after 3 months of follow-up is 7.397 ± 0.7013 (Mean ± SD). The p value is <0.0001, means improvement in the value of HbA1C is statistically significant (paired t test applied).

Table 4 shows in group 1 patients (n=16), mean pre motor NCV (Rt. median nerve) m/s is 47.51 ± 2.165 (Mean ± SD) and post motor NCV (Rt. median nerve) m/s 47.18 ± 2.27 (Mean ± SD). The difference between pre and post value is statistically insignificant as p value is 0.1671(paired t test applied). Where as in group 2 patients (n=34), the mean pre motor NCV (Rt. median nerve) m/s is 46.59 ± 2.432 (Mean ± SD) and post motor NCV (Rt. median nerve) m/s is 47.09 ± 2.216 (Mean ± SD). This result is statistically significant (paired t test applied) as p value is 0.0044 and there is increase in NCV from 46.59 ± 2.432 to 47.09 ± 2.216 (Table 4).

Table 5 shows in group 1 patients (n=16), mean pre sensory NCV (Rt. median wrist) m/s is 49.87 ± 2.137 (Mean ± SD) and post sensory NCV (Rt. median wrist) m/s 49.39 ± 2.349 (Mean ± SD). The difference between pre and post value is statistically insignificant as p value is 0.0901. Statistically insignificant (paired t test applied) means reduction of NCV from 49.87 ± 2.137 to 49.39 ± 2.349 (Pre to post) in patients showing deterioration of HbA1C value (Table 5). In contrast, group 2 patients (n=34), the mean pre sensory NCV (Rt. median wrist) m/s is 48.82 ± 1.811 (Mean ± SD) and post sensory NCV (Rt. median wrist) m/s is 49.62 ± 2.103 (Mean ± SD). The increase in NCV from 46.59 ± 2.432 to 47.09 ± 2.216 is statistically significant as p value is 0.0001 (paired t test applied).

Here in Table 6 in group 1 patients (n=16), the mean pre motor NCV (Lt. median nerve) m/s is 47.63 ± 2.183 (Mean ± SD) and post motor NCV (Lt. median nerve) m/s is 47.11 ± 2.408 (Mean ± SD). The difference between pre and post value is statistically significant as p value is 0.0081, means reduction of NCV from 47.63 ± 2.183 to 47.11 ± 2.408 in patients showing deterioration in HbA1C value is statistically significant (paired t test applied) (Table 6). In comparison, group 2 patients (n=34), the mean pre motor NCV (Lt. median nerve) m/s is 46.65 ± 2.511 (Mean ± SD) and post motor NCV (Lt. median nerve) m/s is 47.28 ± 2.186 (Mean ± SD). This result is again statistically significant (paired t test) as p value is 0.0018 and there is increase in NCV from 46.65 ± 2.511 to 47.28 ± 2.186 (pre to post).

In Table 7 in group 1 patients (n=16), mean pre sensory NCV (Lt. median wrist) m/s is 50.12 ± 2.339 (Mean ± SD) and post sensory NCV (Lt. median wrist) m/s 49.55 ± 2.412 (Mean ± SD). The difference between pre and post value (reduction of NCV) is statistically significant as p value is 0.0214 (paired t test applied) (Table 7). Where as in group 2 patients (n=34), the mean pre sensory NCV (Lt. median wrist) m/s is 49.52 ± 2.536 (Mean ± SD) and post sensory NCV (Lt. median wrist) m/s is 50.01 ± 2.221 (Mean ± SD). Here increase in NCV value is statistically significant (paired t test applied) as p value is 0.0219.

DISCUSSION

The present prospective observational study was conducted to evaluate relation between Nerve Conduction Velocities (NCV) with glycemic control of diabetic neuropathy in type 2 diabetic patients.

Present study was conducted in 50 patients. Out of 50, 32/50 (64%) are male and 18/50 (32%) are female. The mean age of presentation of diabetic neuropathy is 58.32 ± 9.629 (Mean ± SD) including both male and female. Age group most commonly affected is between 55-59 years. The mean

age of onset of neuropathy in male group is 59.22 ± 8.794 (Mean ± SD) and the mean age of onset of neuropathy in female group is 56.72 ± 11.04 (Mean ± SD). Difference between onset of neuropathy in male and female group is statistically insignificant, as P value is 0.38.

A retrospective cross sectional study carried out at Department of Neurology, Mayo Hospital, Lahore, over a period of six months from September, 2011 to February, 2012. A total of 125 patients were included in the study with 57/125 (45.6%) males and 68/125 (54.4%) females. The mean age of onset of DPN was (50.87 ± 9.43) years in men and (49.25 ± 10.62) years in female but in present study (59.22 ± 8.794) years in male and (56.72 ± 11.04) years in female. Late onset of neuropathy and difference in sex distribution in male and female group probably duo to different sample size, different study type or duo to pharmacogenetics.

In the present study, patients with improved glycemic control (group 2, n=34) show an increase in motor NCV (Nerve Conduction Velocity) in right median nerve (p=0.0044) and left median nerve (p=0.0018) along with sensory NCV in right median wrist (p=0.0001) and left median wrist (p=0.0219). The increase in NCV is statistically significant in all four types as p value is <0.05, where as in patients in whom glycemic control deteriorates (group 1, n=16), shows decrease in motor Nerve Conduction Velocity (NCV) in right median nerve (p=0.1671), left median nerve (p=0.0081) and sensory Nerve Conduction Velocity (NCV) in right median wrist (p=0.0901) and left median wrist (p=0.0214). Here the decrease in nerve conduction velocity in left median nerve and left median wrist is statistically significant (p<0.05), but in case of right median nerve and right median wrist this decrease NCV is not statistically significant (p>0.05).

This study results are very much in line with a study done at Government Medical College, Aurangabad. Maharashtra, India, showing decrease in nerve conduction velocity was more in diabetics with poor glycemic control as compared to patients with good glycemic control and this difference was statistically highly significant. Similarity between both the studies probably is due to same kind of population as both the studies are done at India.

A study done at Gulbarga, undertaken for a period of 8 months on 90 subjects including both male and females shows Nerve Conduction Velocity (NCV) progressively decreased from diabetics with good glycaemic control to the diabetics with poor glycaemic control. There is negative correlation between sensory nerve conduction velocity & glycemic control (HbA1C). There is progressive slowing of sensory nerves in diabetics which is accelerated by poor glycemic control. This is very much in line with the present study.

Another longitudinal study where, 8 Type 1 diabetics peripheral neuropathy were studied, first in conditions of poor metabolic control and then after one and three months during which an improved control of glycemic levels had been obtained by continuous subcutaneous insulin infusion. Peripheral neuropathy was investigated by measuring maximum motor conduction velocity of median nerves and sensory conduction velocity of median nerve. Data showed significant improvement of motor conduction velocity, whilst sensory conduction velocity did not show any significant variation. In contrast, the present study was conducted in Type 2 diabetic patients and both the motor and sensory nerve conduction velocity was increased with improved glycemic control. Difference regarding sensory nerve conduction is probably due to different type of diabetes, difference in sample size or different age and sex distribution.

CONCLUSION

Diabetic neuropathy is the presence of symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after the exclusion of other causes. Diabetic neuropathy occurs in ~50% of individuals with long standing type 1 and type 2 diabetes mellitus. It may manifest as a poly neuropathy, mono neuropathy or autonomic neuropathy. The most common form of diabetic neuropathy is Distal Symmetric Polyneuropathy (DSPN). As with other complications of diabetes, the development of neuropathy correlates with the duration of diabetes and glycemic control. The treatment of diabetic neuropathy is less than satisfactory. Optimal glycemic control should be aggressively pursued and will improve nerve conduction velocity.

The present study was conducted on 54 Type 2 diabetes mellitus patients with symptoms of diabetic neuropathy diagnosed by the attending physician among whom 50 are available for follow up. Patient included in the study has been screened on the 1st visit and next after 3 months. Nerve Conduction Velocity (NCV) has been evaluated. For motor component values of Right (RT) and Left (LT) median nerve conduction velocity and for sensory component values of Right (RT) and Left (LT) median wrist conduction velocity has been taken. First Nerve Conduction Velocity (NCV) was done at the entry point of the study and secondly after 3 months. To evaluate glycemic control Glycosylated Hemoglobin (HbA1c) values were noted at the beginning of the study and then 3 months later.

Patients participating in the present study (n=50), 16 patients show deterioration in HbA1C value and 34 patients shows improvement in HbA1C value after a period of 3 months of follow-up. Those 16 patients in whom HbA1C value deteriorate comprising group 1 and 34 patients in whom HbA1C value improved comprising group 2. Both deterioration and improvement of HbA1c value in group 1 and group 2 respectively was statistically highly significant.

On comparing nerve conduction velocity between pre and post value in group 2, both motor NCV in right median nerve and left median nerve was increased and was statistically significant. Both sensory NCV in right median wrist and left median wrist was increased compare to pre value and the increase in NCV value again statistically significant. In group 1 patients in whom HbA1c value deteriorate, motor NCV of right median nerve and sensory NCV of right median wrist decrease compared to pre value, but this reduction of NCV was found to be insignificant. Whereas reduction of NCV of left median nerve and left median wrist was found significant.

Although the present study had several limitations e.g. small sample size, small duration and it is a unicentric observational study, the results demonstrated that change in nerve conduction velocity was related to optimal glycemic control and improvement in glycemic control was related to increase in nerve conduction velocity in diabetic neuropathy.

CONFLICT OF INTEREST

There are no conflicts of interest.

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