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RESEARCH ARTICLE

EFFECT OF SMOKING ON NERVE CONDUCTION VELOCITY IN TYPE 2 DIABETES MELLITUS PATIENTS

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ABSTRACT

Background: India has one of the highest prevalence of Diabetes mellitus globally. One of the leading micro-vascular complication of diabetes mellitus is diabetic neuropathy. Smoking is a huge public health problem in India and is known to affect blood supply of peripheral nerves. Hence, both smoking and diabetes mellitus can adversely affect the peripheral nervous system. **Aim & Objectives:** To study the effect of tobacco smoking on nerve conduction velocity in male patients with type 2 diabetes mellitus. **Materials & methods:** The study comprised of 3 groups with 25 individuals each. Group A – Non diabetic, non smoking healthy volunteers.
Group B – Non smoking individuals with diabetes mellitus type 2.
Group C - Individuals with diabetes mellitus type 2 who were smokers.
Every individual in each of the group was subjected to right median nerve motor and sensory nerve conduction studies, right peroneal motor nerve conduction studies and right sural sensory nerve conduction studies, in accordance to established parameters. **Results:** Sural sensory NCV was significantly lower ($P<0.05$) in the diabetic smokers (group C) as compared to controls (group A) and diabetic non-smokers (group B). Median sensory NCV was significantly lower ($P<0.05$) in the diabetic smokers (group C) as compared to non-smokers (group B). **Conclusion:** In smokers with diabetes there is subclinical reduction in sensory nerve conduction velocities suggestive of earlier onset of peripheral diabetic neuropathy.

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INTRODUCTION

Diabetes Mellitus (DM) is the group of metabolic disorders characterized by hyperglycaemia resulting from either defect in insulin secretion, its action or both. It is worldwide problem which pose a significant health care burden to society and contributes significantly to morbidity & mortality. There is a higher prevalence of DM in India (4.3%) and it is growing at alarming rate (Sadikot *et al*., 2004; Pirart, 1977) Among various complication of diabetes, diabetic neuropathy (DN) is considered one of the most common microvascular complications. The resultant loss of function in peripheral nerves causes loss of protective sensations and impairs patient's ability to perceive incipient or even apparent ulcerations in the feet (Wang *et al*., 2014; Wakode, 2018). In a study, the incidence of neuropathy increased from 7.5% on admission to 50% at 25 years follow up (Pirart, 1977).

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The cause of DN though remains unknown but In DM , ischaemic and metabolic components are implicated as possible causes for Diabetic peripheral neuropathy. Hyperglycaemia by increasing endothelial vascular resistance can reduce nerve blood flow, further hyperglycaemia leads to activation of polyol pathway and also induces oxidative stress. . Endoneural hypoxia is produced by increased vascular resistance and reduced blood flow in the nerve leads to axonal atrophy and impairment of nerve conduction (Cameron *et al*., 2001; Bansal, 2006). Prevalence of tobacco use in Indian is very high with male preponderance, nearly one quarter of nation's population use tobacco either as a smoke or smokeless form. Cigarette smoke is a complex mixture of chemical compounds containing many free radicals and oxidants, which cause imbalance of antioxidant defence system resulting in oxidative stress, this oxidative stress due to smoking can affect the nerve blood flow as well (Low, 1997; Richardson, 2004; Shrivastava, 2017). Chemicals like nicotine, tar, carbon monoxide present in tobacco have been implicated in causing subclinical changes in myelin sheaths of peripheral nerves.

This may result in nerve dysfunction particularly in the form of decrease in nerve conduction velocity (NCV) and its chronic exposure can results in peripheral neuropathy (Sharma, 2016; Gokhan *et al*., 2003). However, there are very few studies available in literature demonstrating effect of smoking on NCV in diabetic subjects, therefore this present study was planned to see the effects of cigarette smoking on nerve conduction velocity among DM patients.

METHODS

The present analytical observational study was part of postgraduate research programme for physiology at one of the medical college, in Jaipur Rajasthan. Prior approval from the institutional ethics committee and research review board was taken. A total of 75 male subjects in the age group of 30 to 60 years participated in the study, which consisted of 50 type 2 diabetic mellitus patients with disease duration of less than 5 years and 25 healthy subjects as control.

Diabetic patients were on regular anti diabetic medication without any signs or symptoms suggestive of diabetic peripheral neuropathy, they were further divided in to two groups based on history of smoking. Out of these 25 patients were diabetic non smokers and labelled as (group B) and 25 patients were tobacco users (group C) and 25 healthy control represented group A. Smokers were defined as anyone who was currently smoking either cigarettes or beedi's.

Exclusion criteria: Diabetic female patients , and any patients with history of type-I diabetes on Insulin, alcohol abuse , hypertension, peripheral neuropathy, injuries to upper limb ,deformity and those with any other systemic , endocrine or neurological disorder were excluded from the study.

Laboratory protocol for recording NCV: Nerve conduction study was carried out on right upper and lower limb using RMS EMG-EP Mk 3 instrument. Standard recording protocol was followed to carry out the procedure (Kimura, 1979; Wakode, 2013). Right Median motor and sensory nerve conduction velocity was recorded from upper limbs, and right peroneal motor and sural sensory NCV was recorded from lower limbs. Antidromic stimulation was used for recording upper limb median sensory NCV and lower limb sural sensory NCV.

All the recordings were taken in lying position on examination couch at 25°C room temperature, limb temperature was maintained between 32-34 °C. Nerve conduction study parameters were obtained at following instrument setting: For motor studies: sensitivity: 2-5 mv mm^{-1}, low frequency filter: 2-5 Hz, high frequency filter: 10 KHz, sweep speed: 1-2 ms mm^{-1}. For sensory studies: sensitivity: 10-20 μv mm^{-1}, low frequency filter: 2-3 Hz, sweep speed: 2-7 ms mm^{-1} (Gokhan, 2003). NCV data was compiled and manually entered in excel sheet for analysis.

Statistical Analysis: Data was analyzed with statistical package SPSS-20. Descriptive statistics was employed to obtain mean and standard deviation of nerve conduction velocity of different nerves. Differences between the mean among the groups were compared by one way ANOVA. Bonferroni post hoc test was used for studying multiple comparisons between groups. P value < 0.05 was considered statistically significant.

RESULTS

Baseline and general demographic findings are shown in table 1. All the study groups were age and weight matched and no significant difference were observed between different groups. Average duration of disease for diabetic non-smokers was 4.04(±0.97) years and that for diabetic smokers was 3.96(±1.17) years.

Nerve conduction velocity findings: Statistically significant difference for the mean values of sural and median sensory conduction velocity was seen between groups as determined by one-way ANOVA. A Bonferroni's post hoc test revealed that sural sensory NCV was significantly lower (P<0.05) in the diabetic smokers as compared to controls and diabetic non-smokers, while median sensory NCV was significantly lower (P<0.05) in the diabetic smokers as compared to non-smokers.(table 2). Mean values of peroneal and median motor nerve conduction velocity was found to be lower in diabetic groups but it was not statistically significant (P>0.05) (table 2)

DISCUSSION

In the present observational study the effect of smoking on nerve conduction velocity was studied among type 2 DM patients. Sural and median sensory nerve conduction velocity was significantly lower in diabetic smokers as compared to non smokers. When compared with control groups lower limb sural sensory nerve conduction velocity was also found to be lower in both the diabetic groups irrespective of smoking. It is known that peripheral nerve dysfunction which is one of the most common micro-vascular complication of diabetes is manifested relatively early in nerves of lower limbs (Kakrani, 2014). Similar to this observation, present study has shown reduced lower limb sensory nerve conduction in diabetic groups as compared to controls. NCS primarily evaluates large myelinated fibers of peripheral nerves and reduction of conduction velocity is suggestive of loss of myelin. Previous studies had shown that nerve conduction abnormalities can be seen before manifestations of clinical symptoms in diabetic patients (Wakode *et al*., 2018; Cameron *et al*., 1988; Herbert, 2017; Tupkovic *et al*., 2007).

In agreement to these findings the present study had shown reduced sensory nerve conduction in upper and lower limbs. Moreover several studies have demonstrated that smoking by itself induces subclinical changes in myelin sheath leading to demyelination of nerves and consequently a decrease in nerve conduction velocity (Agrawal *et al*., 2007; Tayade, 2012). Unlike the sensory NCV findings, in our study there was no significant difference in median motor conduction velocity of upper limbs among the different study groups. These findings were similar to the observations made by previous studies (Tayade, 2012; Behse, 1977). However, in contrast to this, Arora *et al*. (Arora, 2018) reported subclinical decrease in motor nerve conduction velocity among heavy smokers. This may be due to the fact that sensory nerves are thinner than motor nerves and have shorter internodal distance. As a rule, thinner nerves are usually affected much earlier than thicker nerves. Hence the earlier involvement of sensory nerves compared to motor nerves (Low, 1997; Shrivastava, 2017). Chemicals in tobacco and cigarette smoke like nicotine, tar, carbon monoxide etc. have been implicated in causing subclinical changes in myelin sheaths of peripheral nerves and

Table 1. Demographic Data in the study groups

Parameter	Control n=25	Diabetic non smoker n=25	Diabetic smoker n=25	*P*
Mean age Years M (SD)	48.92(±8.94)	49.72(±9.14)	49.64(±8.83)	P>0.05
Weight in Kilograms M(SD)	63.72(±6.32)	62.88(±6.52)	63.28(±7.32)	
Average duration of disease	0	4.04(±0.97)	3.96(±1.17)	

Table 2. Comparison of Nerve Conduction Velocity (NCV) in the study groups

Parameter	Nerves	Group A Control (n=25) M±SD	Group B Diabetic Non mokers (n=25) M±SD	Group C Diabetic smokers (n=25) M±SD	Anovadf (2,72)	*P value*
Motor NCV (m/s)	Median	55.95 ± 3.18	54.02 ± 3.54	54.48± 3.11*	F(2,72) = 2.33	0.105 Not significant
	Peroneal	51.94 ± 4.04	51.55± 4.38	50.78± 4.38*	F(2,72) = 0.480	0.621 Not significant
Sensory NCV (m/s)	Median	56.81 ± 5.50	54.99±5.07	50.72± 8.03*#	F(2,72) =6.08	0.004
	Sural	49.76 ± 5.94	45.80±4.24	40.67± 5.25*#	F(2,72) =19.22	0.0001

the resulting demyelination can causes poor electrotonic conduction (Richardson, 2004; Shrivastava, 2017). It is estimated that East Asian countries including India accounts for 38% of global smokers (Xia *et al*., 2019). And confounding this problem is that India has one of the highest global prevalence of diabetes. Considering these, it is imperative to encourage the urgent need for individuals to quit smoking to prevent further complications and increase in morbidity. All the smokers in the study were actively encouraged to quit smoking and were enrolled into workshops aimed at quitting smoking.

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Conflict of Interest: There are no conflicts of interest

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Glossary of Abbreviations:

ANOVA – Analysis of Variance
°C – Degree Celcius
DM – Diabetes Mellitus
DN – Diabetic Neuropathy
Hz – Hertz
KHz - Kilo Hertz
mv mm^{-1} – millivolt per millimetre
ms mm^{-1} – millisecond per millimetre
NCV – Nerve Conduction Velocity
NCS – Nerve Conduction Study
SPSS – Statistical Package for Social Sciences
µv mm^{-1} – microvolt per millimetre

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