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Study of Reaction Time and Glycated Hemoglobin (HbA1c) in T2DM Patients

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ABSTRACT

Diabetic neuropathy (DN) is a disorder of the nerve caused by diabetes mellitus which may be diffused or focal. Symptoms usually develop gradually over years and are non-specific. Therefore, there is a need for tests to identify the affect of hyperglycemia on nervous tissue at the early stage. Reaction time (RT) is an index of processing ability of the central nervous system (CNS). Therefore, this study was undertaken intended to examine the reaction times in Type 2 Diabetes mellitus (T2DM). The present case control study was conducted on 60 T2DM patients and 60 healthy volunteers who were male, right handed and aged between 40-80 years. The subject's anthropometric parameters, auditory reaction time (ART), visual reaction time (VRT) and cutaneous reaction time (CRT) were measured. Blood samples were obtained in the fasting state for estimating fasting blood sugar (FBS) and Glycated hemoglobin (HbA1c). The values of the cases and controls were compared and analyzed statistically. T2DM patients had significant increase ($p<0.01$) in all the reaction times. Pearson's correlation of reaction time parameters with diabetic duration, FBS and HbA1c showed the presence of significant correlation between the reaction time parameters and diabetic duration. Also, there was significant positive correlation between HbA1c and reaction time parameters. On comparing various parameters between the diabetics with good glycemic control (HbA1c<7%) and without good glycemic control (HbA1c≥7%), diabetics with good glycemic control had significantly shorter reaction times though there was no significant difference in diabetic duration. T2DM patients manifest with slowing reaction times that is associated with poorer metabolic control.

Keywords: T2DM, Glycated hemoglobin (HbA1c), Reaction time

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INTRODUCTION

Type 2 Diabetes mellitus (T2DM), the most common endocrine disorder due to insulin resistance is responsible for significant morbidity and mortality because of various complications that it is associated [1]. Diabetic neuropathy (DN) is one of the complications accounting for 28% of all the complications in diabetics [2]. It is a disorder of the nerve caused by diabetes mellitus which may be diffused, affecting several parts of the body, or focal, affecting a specific nerve and part of the body. Symptoms usually develop gradually over years and are non-specific [3]. Therefore, there is a need for tests to identify DN before the development of serious complications like cognitive disabilities and diabetic foot.

Reaction time (RT) is an index of processing ability of the central nervous system (CNS). It is used in experimental physiology to assess sensory-motor performance. It is the time interval between the onset of a signal (stimulus) and the initiation of a movement response. This is being used in mental chronometry, psychometric psychology and in training mentally challenged children. Reaction time is also utilized by athletes for better performance [4].

The previous studies have shown that T2DM had poor cognitive abilities and psychomotor abilities due to 'central neuropathy' [5,6]. Since, reaction time is an index of processing ability of the CNS, this study intended to examine the reaction times in T2DM patients and compare with the nondiabetic peers.

MATERIALS AND METHODS

The present case control study was conducted on 60 T2DM patients and 60 healthy volunteers who were right handed and aged between 40-80 years. In order to avoid the gender bias only male patients were included. Subjects had clinically normal hearing and vision. They were not practicing any long term exercises, sports or yogic postures previously. Smokers, alcoholics and subjects with other chronic illness like hypertension were excluded.T2DM patients with complications were also excluded. Selected subjects were briefed about the study protocol and written informed consent was obtained. The subject's anthropometric parameters were recorded. Auditory reaction time (ART), visual reaction time (VRT) and cutaneous reaction time (CRT) were measured. In order to avoid the familiarity bias, a session was organized to familiarize the participants to instrument and to train them on the test process. Only later the actual values were obtained. Blood samples were obtained on the next day in the fasting state. Samples were used for estimating fasting blood sugar (FBS) and Glycated hemoglobin (HbA1c). The values of the cases and controls were compared and analyzed statistically using student t test and Pearson's correlation.

RT was measured in a quiet secluded room whose ambient temperature was about 27°C, between 10 AM and 12.30 PM. RT was assessed by making use of an instrument, RESPONSE –ANALYSER. It has an audio mode, visual mode and cutaneous mode for ART, VRT and CRT respectively. The instrument has 2 buttons, first one is a start button, handled by the examiner to deliver the stimulus and the second button is the stop button (response switch),

which is to be pressed by the participant when he perceives the stimulus. Thumbs of right and left hands of each subject were being used alternatively to press response switch to get reading for that particular hand. For ART, stimulus was delivered through a head phone of capacity 1000 Hz tone and for VRT; visual stimulus was through a glowing bulb. Start and stop buttons are connected to a computer which records the reaction time in milliseconds. CRT test measures the response to a cutaneous (touch) stimulus. Cutaneous mode was selected. Here the stimulus was contact between the plunger and the skin. Subjects were asked to press the response switch as soon as the touch with the plunger was felt by the other hand. The reading on the display indicated response time to the cutaneous stimulus in milliseconds.

RESULTS

The results obtained are tabulated in tables 1, 2 and 3. Table 1 shows the comparison of parameters in T2DM patients and healthy controls. It shows that, in T2DM patients there was significant increase ($p<0.01$) in all the reaction times. Table 2 shows the Pearson's correlation of reaction time parameters with diabetic duration, FBS and HbA1c.It is shown that the there was statistically highly significant correlation between the reaction time parameters and diabetic duration. Also, there was significant positive correlation between HbA1c and reaction time parameters. Table 3 shows the comparison of various parameters between the diabetics with good glycemic control (HbA1c<7%) and without good glycemic control (HbA1c≥7%). Diabetics with good glycemic control had significantly shorter reaction times though there was no significant difference in diabetic duration.

Table 1: Shows the comparison of various parameters between controls and cases

Parameters	Controls	Cases	P VALUE
AGE (years)	54.97 ± 8.20	56.82 ± 9.84	0.27 (NS)
FBS (mg/dl)	92.00 ± 8.28	163.12 ± 20.13	<0.01 (HS)
HbA1c (%)	4.62 ± 0.45	7.71 ± 1.04	<0.01 (HS)
ART Right (m.sec)	168.97 ± 16.21	176.50 ± 16.22	0.01 (S)
ART Left (m.sec)	169.91 ± 16.29	177.57 ± 16.12	0.01 (S)
VRT Right (m.sec)	173.83 ± 16.68	181.53 ± 15.82	0.01 (S)
VRT Left (m.sec)	174.71 ± 16.45	182.86 ± 15.65	0.01 (S)
CRT Right (m.sec)	179.37 ± 16.70	187.14 ± 15.42	0.01 (S)
CRT Left (m.sec)	180.38 ± 16.46	188.37 ± 15.25	0.01 (S)
Diabetic duration (years)	-	6.03 ± 1.75	-

The values are expressed as their Mean ± SD
HS = Highly significant ($p<0.01$)
S = Significant ($p<0.05$)
NS = Not significant ($p>0.05$)

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Table 2: Shows the Pearson's correlation of reaction time parameters with diabetic duration, FBS and HbA1c

Reaction time parameters:		ART Right	ART Left	VRT Right	VRT Left	CRT Right
Diabetic duration (years)	r value	r=0.36	r=0.36	r=0.37	r=0.37	r=0.35
	p value	<0.01 (HS)	<0.01 (HS)	<0.01 (HS)	<0.01 (HS)	<0.01 (HS)
FBS (mg/dl)	r value	r=0.10	r=0.10	r=0.06	r=0.06	r=0.03
	p value	0.4 (NS)	0.4 (NS)	0.6 (NS)	0.6 (NS)	0.8 (NS)
HbA1c (%)	r value	r=0.27	r=0.28	r=0.30	r=0.30	r=0.31
	p value	<0.05 (S)	<0.05 (S)	<0.05 (S)	<0.05 (S)	<0.05 (S)

HS = Highly significant (p<0.01)
S = Significant (p<0.05)
NS = Not significant (p>0.05)

Table 3: Shows the comparison of various parameters between the diabetics with and without good glycemic control

Parameters	HbA1c ≥ 7%	HbA1c <7%	p value
AGE (years)	56.42 ± 9.46	57.82 ± 10.99	0.62 (NS)
FBS (mg/dl)	162.84 ± 20.58	163.82 ± 19.52	0.87(NS)
Diabetic duration (years)	6.19 ± 1.71	5.65 ± 1.84	0.29 (NS)
ART Right (m.sec)	179.10 ± 17.46	169.92 ± 10.30	0.05 (S)
ART Left (m.sec)	180.23 ± 17.36	170.84 ± 9.98	0.04 (S)
VRT Right (m.sec)	184.43 ± 16.73	174.19 ± 10.42	0.02 (S)
VRT Left (m.sec)	185.71 ± 16.57	175.64 ± 10.26	0.02 (S)
CRT Right (m.sec)	190.22 ± 16.11	179.34 ± 10.23	0.01 (S)
CRT Left (m.sec)	191.48 ± 15.90	180.52 ± 10.14	0.01 (S)

The values are expressed as their Mean ± SD
HS = Highly significant (p<0.01)
S = Significant (p<0.05)
NS = Not significant (p>0.05)

DISCUSSION

In India, Diabetes mellitus showed the prevalence of 7.1 % in 2010 and expected to rise to 8.6% by 2030 [7]. In the view of the rise in diabetic population, further rise in complications is expected and thereby increasing the morbidity and mortality. In this context there is an ongoing search for the tools for early identification of the onset of complications. The tools are expected to be simple and should be able to perform at out patient depatments (OPD). Diabetic neuropathy, being one of the common serious complications affecting nerves accounting for morbidity and mortality in T2DM patients. Reaction time tests are simple and non invasive tests and are performed to assess the processing ability of CNS. Therefore, this study was undertaken to find the utility of reaction time parameters in T2DM patients to identify the early onset of neuropathy.

The studies have showed that T2DM patients had longer reaction times which were statistically significant. This is in accordance with the previous studies [8,9]. On Pearson's

correlation of reaction time parameters with diabetic duration, FBS and HbA1c, it is shown that the there was statistically significant positive correlation between the reaction time parameters and diabetic duration i.e longer the diabetic duration delays the reaction time. Also, there was significant positive correlation between HbA1c and reaction time parameters which mean poor glycemic control had an adverse effect on reaction time parameters. The comparison of various parameters was also made between the diabetics with good glycemic control (HbA1c<7%) and without good glycemic control (HbA1c≥7%). Diabetics with good glycemic control had significantly shorter reaction times indicating the importance of good metabolic control. There was no significant difference in diabetic duration between the diabetics with good glycemic control (HbA1c<7%) and without good glycemic control (HbA1c≥7%) indicating the importance of metabolic control irrespective of diabetic duration.

This study also showed that reaction times did not correlate with FBS but correlated only with HbA1c significantly in T2DM. The probable reason may be that, Reaction times study is a physiological tool which is an index of long duration of health status and HbA1c, an indicator of long duration of glycemic control [10]. But, FBS is subjected to variations. Improvement on the reaction time means reversibility of the neuropathic changes to the T2DM patients. It has been shown that reaction times can be improved by various forms of exercises like yoga [11]. Being a cross sectional study is the limitation of this study. Follow up of the patients after the intervensions for glycemic control and exercise can improvise this study.

In conclusion, T2DM patients manifest with slowing reaction times that is associated with poorer metabolic control. Thus, RT is helpful in identifying early neuropathic affect and after the institution of RT improvement measures; it can be of usefull as a monitoring tool.

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