Classical autonomic function tests in type 2 diabetes mellitus patients with different HbA1c levels: A comparative study

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Abstract

Introduction: Autonomic dysfunction is one of the sequels in type 2 Diabetes Mellitus and various diagnostic tests have been developed for assessing it. Analysis of classical autonomic function test is one among them.

Aims and Objectives: To compare the classical autonomic function tests in good control, poor control and very poor control type 2 diabetes mellitus.

Materials and Methods: This study was conducted at the PSG Institute of Medical Sciences and Research, Coimbatore, Tamil Nadu, India, on 30 patients with type 2 diabetes mellitus.HbA1c investigations was done for all 30 patients. Average age of the Diabetic patients was 48.53 ± 5.12 (Mean ± SD). After obtaining informed, written consent, cardiorespiratory parameters such as resting heart rate (HR), systolic blood pressure, and diastolic blood pressure were measured after 10 min of supine rest. Autonomic function parameters such as HR and blood pressure response to handgrip, deep breathing difference test, and Valsalva ratio were recorded in them.

Results: Statistical analysis was done using students's t-test, which showed statistically non-significant impairment between good control and poor control and very poor control subjects.

Conclusion: Results of this study showed autonomic impairment was present in all 3 groups of Type 2 diabetes and statistically not significant differences in impairment were noticed between the groups. This showed autonomic impairment starts and persists from the onset of type 2 diabetes.

Keywords: Type 2 diabetes, HbA1c, Classical autonomic function tests.

Introduction

Type 2 DM is a group of metabolic diseases with high blood glucose either due to lack of insulin or decreased response of tissues to insulin.[1] Diabetes is consider as a prime factor causing high mortality worldwide and fifth leading cause of death all over the world that is 6.8% of deaths attributed to diabetes.[2] The American Heart Association considered diabetes as "CHD risk equivalent". Diabetes sometimes does not have typical chest pain which is called as silent ischemia.

Cardiac autonomic neuropathy results from injury to the autonomic nerve fibers which innervated the heart and blood vessels hence results in altered heart rate control and vascular dynamics.[3] Altered heart rate control, HR not responding to exercise, stress and sleep indicates complete cardiac denervation with severe cardiac autonomic neuropathy.[4] In diabetes mellitus, orthostatic hypotension develops because of damage to sympathetic vasomotor outflow fibers that leads to faintness, giddiness and syncope.[5]

Unexpected sudden deaths occur in CAN. Intracardiac sympathetic imbalance predisposes to arrhythmias and increase mortality in Diabetics.[6] By using classical autonomic function tests in diabetics, cardiac complications are identified early and appropriate intervention to be taken to prevent morbidity and mortality. Assessment of AFTs like handgrip dynamometer, orthostatic hypotension and heart rate change to deep breath, valsalva manures provides details of sympathetic and parasympathetic function.

HbA1c refers to Glycated hemoglobin. HbA1c levels in the blood indicate average glucose concentration in the plasma. In diabetes mellitus HbA1c is high which indicates poorer control of blood glucose levels. This has been associated with increased risk of developing into cardiovascular disorders. Monitoring HbA1c level in type 2 diabetes patients may improve the outcome of the disease.

Materials and Methods

After obtaining ethical committee approval, the study was carried out in 30 type 2 DM patients who were regularly visiting diabetic OPD in PSG Hospitals. Persons with cardiac disorders, smokers, Alcoholics and Asthmatics were excluded in this study. The Data collection tool is a protocol that has patient data, history, physical examination findings and investigation details. The subjects who fulfilled the criteria were taken for autonomic function tests in Physiology Research lab in PSG IMS&R.

The subjects were divided into 3 groups based on HbA1c levels as good control, poor control and very poor control. Classical autonomic function parameters like heart rate and blood pressure response to isometric handgrip, deep breathing and valsalva ratio were recorded after explaining the procedure.

Hand Grip Dynamometer

After 5 minutes of rest, the subjects were asked to grip dynamometer as maximally as possible with the dominant hand and readings noted. Then subjects were asked to grip 1/3 of the maximal value and sustain at the level for 3 minutes. Heart rate and blood pressure were recorded before releasing the grip.

Deep Breathing Test

Heart rate was recorded by lead II ECG. Respiratory probe was tied over the chest wall and the subject was instructed to inspire deeply for 5 sec and expire maximally for 5 sec for 6 cycles. The ratio of shortest RR interval in inspiration to longest RR interval in expiration was calculated. This is called as E/I ratio.

Valsalva Ratio

This test was carried out by instructing the patients to forcefully exhale against closed glottis into a tube connected to the BP apparatus and sustain the pressure at 40 mmHg for 15 sec and ECG was recorded. Valsalva ratio which is the ratio of the longest RR interval in phase 4 to the shortest RR interval in phase 2 was calculated.

Statistical Analysis

The analysis was done using SPSS software by independent student's test.

Results

Average age of the patients with DM was 48.53 ± 5.12 years (mean ± SD)

Group 1 HbA_Ic – Good control group

Group 2 HbA_Ic – Poor control group

Group 3 HbA_Ic – Very poor control group

Table 1: Autonomic function tests in 3 groups of Type 2 DM

Parameter	Mean ± SD		
	Group 1 HbA_Ic < 7.5%	**Group 2** HbA_Ic 7.5% - 9%	**Group 3** HbA_Ic >9%
DBP rise After hand grip	3.38 ± 1.7	3.2 ± 1.03	3.2 ± 1.10
Heart rate rise After hand grip	6.62 ± 1.7	6.60 ± 1.8	5.4 ± 1.9
E/I ratio	1.102± 0.06	1.08 ± 0.07	1.06 ± 0.06
Valsalva ratio	1.223 ± 0.11	1.17±0.09	1.16 ± 0.09

Table 2: Comparison of autonomic function tests between group 1 and group 2 HbA1c levels

Parameter	Mean ± SD		
	Group 1 HbA_Ic < 7.5%	Group 2 HbA_Ic 1.18%- 9%	**p value**
DBP rise after hand grip	3.38 ± 1.7	3.2 ± 1.03	0.76*
Heart rate rise after hand grip	6.62 ± 1.7	6.60 ± 1.8	0.56*
E/I ratio	1.102± 0.06	1.08 ± 0.07	0.42*
Valsalva ratio	1.223 ± 0.11	1.17 ± 0.09	0.23*

*Statistically not significant

Diastolic blood pressure (DBP) rises after hand grip between good control and poor control group: In good control group the mean rise in DBP after hand grip was 3.38 ± 1.7, in poor control group was 3.2 ± 1.03 and p value is 0.76 which is statistically not significant.

Heart rate rise after hand grip between good control and poor control group: In good control group the mean rise in heart rate after hand grip was 6.62 ± 1.7, in poor control group 6.60 ± 1.8 and p value is 0.56 which is statistically not significant.

E/I ratio in between good control and poor control group: In good control group the mean E/I ratio was 1.102 ± 0.06, in poor control group 1.08 ± 0.07 and p value is 0.42 which is statistically not significant.

Valsalva ratio in between good control and poor control group: In good control group the mean Valsalva ratio was 1.223 ± 0.11, in poor control group 1.17 ± 0.09 and p value is 0.23 which is statistically not significant.

Table 3: Comparison of autonomic function tests between group 1 and group 3 HbA1c levels

Parameter	Mean ± SD		
	Group 1 HbA_Ic < 7.5%	Group 3 HbA_Ic >9%	**p value**
DBP rise after hand grip	3.38 ± 1.7	3.2 ± 1.10	0.67*
Heart rate rise after hand grip	6.62 ± 1.7	5.4 ± 1.9	0.07*
E/I ratio	1.102± 0.06	1.06 ± 0.06	0.43*
Valsalva ratio	1.223±0.11	1.16± 0.09	0.19*

*Statistically not significant

Diastolic blood pressure (DBP) rise after hand grip between good control and very poor control group: In good control group the mean rise in DBP after hand grip was 3.38 ± 1.7, in very poor control group 3.2 ± 1.10 and p value is 0.67 which is statistically not significant.

Heart rate rise after hand grip between good control and very poor control group: In good control group the mean rise in heart rate after hand grip was 6.62 ± 1.7, in very poor control group 5.4 ± 1.9 and p value is 0.07 which is statistically not significant.

E/I ratio in between good control and very poor control group: In good control group the mean E/I ratio was 1.102 ± 0.06, in very poor control group 1.06 ± 0.06 and p value is 0.43 which is statistically not significant.

Valsalva ratio in between good control and very poor control group: In good control group the mean Valsalva ratio was 1.223 ± 0.11, in very poor control group 1.16 ± 0.09 and p value is 0.19 which is statistically not significant.

Discussion

Diabetes mellitus is a group of metabolic diseases with high blood glucose due to lack of insulin or insulin resistance which leads to classical features of polyuria, polydipsia, and polyphagia.[7] Persons with both DM and CVD have poor myocardial function leading to accelerated heart failure the cause being diabetic cardiomyopathy. Cerebrovascular disorders like stroke also is common in diabetes with 3-fold increase in mortality compared to non diabetes.[8] The possible causes to the development of autonomic impairment in DM includes microvascular injury, advanced glycated end products, polyol pathway and protein kinase c.

Glucose level in diabetes fluctuates from minute to minute, hour to hour and day to day, for this glucose level is important guide. The HbAIc level changes slowly, so it could be used as a quality control test.[5] Deep breathing test which is specific for parasympathetic activity was also done in this study. This study found that E/I ratio is less in cases than controls. Hence in diabetics the parasympathetic impairment is significant. This finding is similar to study done by Sundkvist et al.[9]

HbAIc was done only in cases and were divided in to three groups based on the HbAIc levels. Group 1 with HbAIc< 7.5%, group 2 with HbAIc 7.5-9%, group 3 with HbAIc> 9%. Group 1 was taken as good control of diabetes and group 2, group 3 were poor control of DM.

Hand grip test, Deep breath test and Valsalva ratio test of group 2 and group 3 were compared with group 1. First, we compared the autonomic function tests between group 1 and group 2. Results showed there is no statistically significant difference in autonomic dysfunction between these two groups. Second we compared autonomic function tests between group 1 and group 3. This result also showed no statistically significant difference between these two groups.

Hence from the above finding, it is evident that both good and poor glycemic control had no significant difference in autonomic dysfunction. Even good glycemic control patients had similar autonomic impairment as that of poor glycemic control patients.

Conclusion

In this study the important finding is from comparing autonomic dysfunction with different HbAIc levels. The results showed, even patients with good glycemic control had autonomic dysfunction similar to that of poor glycemic control. Hence we found that, if a person develops diabetes irrespective of the glycemic control he continues to have autonomic impairment. This finding is different from other studies. A more detailed study involving more number of diabetes patients is necessary to come to a definite conclusion.

Conflict of Interest: None.

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