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RESEARCH ARTICLE

Study of cardiovascular responses to sustained handgrip and change in posture in Type II diabetes mellitus patients

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ABSTRACT

Background: In India, more than 50% of patients with Type II diabetes have poor glycemic control and these patients suffer from complications of diabetes. One of the major complications of diabetes is impaired cardiovascular autonomic reflexes. Postural tachycardia index, blood pressure (BP) response to sustained handgrip (SHG), and BP response to standing these tests are used to assess cardiovascular autonomic responses. **Aims and Objectives:** This study was done to assess cardiovascular responses to SHG and change in posture in Type II diabetes mellitus patients. **Materials and Methods:** A total of 90 participants were selected out, of which 30 participants had uncontrolled diabetes, 30 had controlled diabetes, and remaining were 30 age- and gender-matched healthy controls. Postural tachycardia index, BP response to SHG, and BP response to standing were measured using Physiopac-8: Computerized 8-channel biopotential acquisition system and Omron Intellisense M3 BP monitor. Data obtained were analyzed statistically. **Results:** Postural tachycardia index values were significantly lower in uncontrolled diabetes patient group as compared to controlled diabetes patient group and healthy control group. The value of BP response to sustained handgrip in uncontrolled diabetes patient group was significantly lower as compared to healthy controls ($P < 0.01$), whereas no statistically significant difference observed between uncontrolled and controlled diabetes patient groups ($P = 0.35$). The value of BP response to standing was significantly higher in uncontrolled diabetes patient group as compared healthy controls ($P < 0.01$), there is a progressive increase in value of fall of BP to standing from healthy control group to uncontrolled diabetes patient group. Value of fall in BP is more in both controlled and uncontrolled diabetes patient group compared to controls but value is greater in patients with uncontrolled diabetes. **Conclusion:** Poor glycemic control leads to impairment of cardiovascular response to change in posture and SHG in Type II diabetes mellitus patients.

KEY WORDS: Uncontrolled Diabetes; Heart Rate Response to Standing; Blood Pressure Response to Standing; Blood Pressure Response to Sustained Handgrip

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INTRODUCTION

The hallmark of diabetes mellitus is hyperglycemia due to defective insulin secretion, insulin resistance, or both.[1] Diabetes mellitus has become modern-day epidemic mainly because of sedentary lifestyle. Currently, diabetes affects 422 million people worldwide. Global prevalence of diabetes in adults is rising very rapidly from 4.7% in 1980 to 8.5% in 2014.[2] Diabetes mellitus is the major cause of blindness, heart attacks, kidney failure, stroke, and lower limb amputation. Research has shown in India more than half the percentage of people with diabetes has very poor glycemic control. Quantitative cardiovascular autonomic function tests which include estimating blood pressure (BP) response to sustained handgrip, heart rate response to supine to standing posture, and BP response to supine to standing posture are commonly used to detect, verify, and quantify the cardiovascular autonomic dysfunction. These tests are very easy to carry out and are non-invasive. Autonomic dysfunction in diabetes is very common but is usually missed. Uncontrolled diabetes leads to autonomic dysfunction which is associated with increased morbidity and mortality. Various studies are done in the past to assess the prevalence and degree of autonomic dysfunction in Type II diabetes mellitus patients but similar types of studies are relatively few in this region. The present study is designed to evaluate and compare cardiovascular responses to sustained handgrip and change in posture in patients with Type II diabetes and age-matched healthy controls. Glycosylated hemoglobin levels are used as a measure of glycemic control.

MATERIALS AND METHODS

A total of 90 participants were selected out, of which 30 participants were having uncontrolled diabetes (glycated hemoglobin [HbA1c] >7, $n = 30$), 30 participants were having well-controlled diabetes (HbA1c <7, $n = 30$), and remaining 30 were age- and sex-matched healthy controls. This study was approved by the Ethical Committee. The present study was carried out in accordance with the Helsinki declaration all participants participated voluntarily after being given a detailed explanation of the purpose of the study. Written and Informed consent were obtained from each participant. Detailed clinical history and thorough clinical examination were performed.

Groups were selected by considering following inclusion and exclusion criteria.

Inclusion and exclusion criteria for different groups.

Type II Diabetes Patients with Poor Glycemic Control ($n = 30$)

All the participant having type II diabetes with HbA1c >7 between the age group of 40-60 years were included in this group.

Type II Diabetes Patients with Good Glycemic Control ($n = 30$)

All the participant having type II diabetes with HbA1c <7 between the age group of 40-60 years were included in this group.

Healthy Controls ($n = 30$)

All non-diabetic participants with HbA1c <6 between the age group of 40-60 years were included in this group. All smokers, alcohol-consuming patients, patients suffering from cardiovascular disease, and patients who were on drugs altering autonomic function test were excluded from the study.

The laboratory tests were done between 7 and 9 a.m. in the laboratory with stable room temperature (22-24°C). The participants were instructed not to smoke, eat, or drink coffee before examination. In the case of the patient with diabetes, antidiabetic medication was given at the end of the examination.

Criteria for the diagnosis of diabetes
HbA1c≥6.5%. The test should be performed in a laboratory using a method that is NGSP certified and standardized to the diabetes control and complication trial assay.* OR
Fasting plasma glucose≥126 mg/dl (7.0 mmol/l). Fasting is defined as no caloric intake for at least 8 h.* OR
2 h plasma glucose≥200 mg/dl (11.1 mmol/l) during an oral glucose tolerance test. The test should be performed using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.* OR
In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose≥200 mg/dl (11.1 mmol/l)
*In the absence of unambiguous hyperglycemia, result should be confirmed by repeat testing[3]

Glycosylated hemoglobin was estimated by modified method of Fluckiger and Winterhalter. Following tests were used to evaluate autonomic function test of all participants: (i) Heart rate response to standing (postural tachycardia index), (ii) BP response to standing, and (iii) BP response to sustained handgrip (SHG).

The participants were asked to relax in supine position for 30 min. Resting heart rate and respiratory activity were recorded by physiopac-8: Computerized 8-channel biopotential acquisition system (Medicaid, Chandigarh) BP was measured with Omron Intellisense M3 BP Monitor. The cardiovascular tests performed are detailed below in the order of execution. These tests were demonstrated to the participants.

Heart Rate Response to Standing (Postural Tachycardia Index)

The participants were asked to lie on the examination table quietly while heart rate is being recorded on electrocardiogram (ECG). They were then asked to stand up unaided and ECG was recorded for 1 min. The shortest R-R interval at or around 15th beat and longest R-R interval at or around 30th beat were measured. The result was expressed as ratio of 30/15. PTI = Longest R-R interval at 30th beat/shortest R-R at 15th beat.

Heart rate response test	Normal	Borderline	Abnormal
Heart rat response to standing (PTI)	1.04 or more	1.01-1.03	1.00 or less

BP Response to Standing (SBP)

The participant was asked to rest in a supine position for 10 min. The resting BP was recorded. The participant was then asked to stand unaided and remain standing unsupported for 5 min. The BP was recorded at 0.5th, 1st, 2nd, 2.5th, and 5th min after standing up. The difference between the resting and standing BP levels was calculated. The fall in systolic BP (SBP) at 30 s on standing noted.

BP response	Normal	Borderline	Abnormal
BP response to standing (fall in SBP)	10 mmHg or less	10-19 mmHg	More than 20 mmHg

BP Response to SHG

Participant were instructed about the test and demonstrated the procedure to use handgrip dynamometer then handgrip dynamometer was given and Participants were asked to grip using maximum force with their dominant hand for few seconds value is noted down and procedure is repeated three times. The maximum value of the three contractions is considered maximal voluntary contraction (MVC). A mark was made at 30% of MVC on handgrip dynamometer. The participant was then instructed to maintain sustained handgrip on dynamometer up to the mark for 4 min and BP is measured in the non-exercising arm at 1st, 2nd, and 4th min. Maximum value of diastolic BP (DBP) was considered final. Then, the rise in DBP was calculated by subtracting resting DBP from this value.

BP response	Normal	Borderline	Abnormal
BP response to SHG (rise in DBP)	16 mmHg or more	11-15 mmHg	10 mmHg or less

RESULTS

The data collected have been statistically analyzed using SPSS version 19.

Comparison of Two Groups

Heart rate response to standing (PTI)

The mean and standard deviation (SD) of patients with uncontrolled diabetes, patients with well-controlled diabetes, and healthy controls are shown in Table 1, which are 1.00 ± 0.037, 1.04 ± 0.063, and 1.09 ± 0.152, respectively. With ANOVA, test difference in the means was statistically significant ($P < 0.01$) among the groups. The decline in postural tachycardia index was highly significant between patients with uncontrolled diabetes and patients with well-controlled diabetes ($P < 0.01$) (Table 2). When difference was compared between patients with uncontrolled diabetes

Table 1: Baseline statistics for three groups

Parameters	*N*	Mean±SD	df	f	*P* value
Postural tachycardia index					
Uncontrolled diabetes	30	1±0.037	2	7.38	0.001
Controlled diabetes	30	1.04±0.063			
healthy controls	30	1.09±0.152			
HbA1c					
Uncontrolled diabetes	30	9.53±1.899	2	90.011	<0.001
Controlled diabetes	30	6.22±0.710			
Healthy controls	30	5.71±0.428			
BP response to standing					
Uncontrolled diabetes	30	12.10±10.7	2	3.9	0.024
Controlled diabetes	30	10.33±4.2			
Healthy controls	30	7.17±3.2			
BP response to SHG					
Uncontrolled diabetes	30	9.33±4.9	2	19.023	<0.001
Controlled diabetes	30	10.83±7.29			
Healthy controls	30	17.47±3.36			

HbA1c: Glycated hemoglobin, BP: Blood pressure, SHG: Sustained handgrip, SD: Standard deviation

Table 2: Basic statistics of uncontrolled diabetes patient group and controlled diabetes patient group

Parameters	*N*	Mean±SD	*P* value
Postural tachycardia index			
Uncontrolled diabetes	30	1±0.037	0.002
Controlled diabetes	30	1.04±0.063	
HbA1c			
Uncontrolled diabetes	30	9.53±1.899	< 0.001
Controlled diabetes	30	6.22±0.710	
BP response to standing			
Uncontrolled diabetes	30	12.10±10.7	0.4
Controlled diabetes	30	10.33±4.2	
BP response to SHG			
Uncontrolled diabetes	30	9.33±4.9	0.354
Controlled diabetes	30	10.83±7.29	

HbA1c: Glycated hemoglobin, BP: Blood pressure, SHG: Sustained handgrip, SD: Standard deviation

and healthy controls, the difference was statistically significant ($P < 0.01$) (Table 3). Moreover, difference in the means between patients with controlled diabetes and healthy controls was statistically insignificant (Table 4)

BP response to standing (orthostatic test)

Mean and SD of BP response to standing are given in Table 1 which are 12.10 ± 10.771, 10.33 ± 4.205, and 7.17 ± 3.239 in patients with uncontrolled diabetes, patients with controlled diabetes, and healthy controls, respectively. There is a progressive increase in value of fall of BP to standing from healthy control group to uncontrolled diabetes. In Table 2, patients with uncontrolled diabetes are compared with patients with controlled diabetes ($P = 0.406$), the value of increase in orthostatic fall in BP in patients with uncontrolled diabetes is statistically insignificant. In Table 3, patients with uncontrolled diabetes are compared with healthy controls ($P < 0.05$) difference in the means is statistically significant. In Table 4, patients with controlled diabetes are compared with healthy controls difference in the mean was statistically significant ($P < 0.01$).

Table 3: Basic statistics for uncontrolled diabetes patient group and healthy control group

Parameters	*N*	Mean±SD	*P* value
Postural tachycardia index			
Uncontrolled diabetic	30	1±0.037	0.001
Healthy control group	30	1.09±0.152	
HbA1c			
Uncontrolled diabetic	30	9.53±1.899	<0.001
Healthy control group	30	5.71±0.428	
BP response to standing			
Uncontrolled diabetic	30	12.10±10.7	0.02
Healthy control group	30	7.17±3.2	
BP response to SHG			
Uncontrolled diabetic	30	9.33±4.9	0.001
Healthy control group	30	17.47±3.36	

HbA1c: Glycated hemoglobin, BP: Blood pressure, SHG: Sustained handgrip, SD: Standard deviation

Table 4: Basic statistics of controlled diabetes patient group and healthy controls

Parameters	*N*	Mean±SD	*P* value
Postural tachycardia index			
Controlled diabetes	30	1.04±0.063	0.07
Healthy controls	30	1.09±0.152	
HbA1c			
Controlled diabetes	30	6.22±0.710	0.001
Healthy controls	30	5.71±0.428	
BP response to standing			
Controlled diabetes	30	10.33±4.2	0.002
Healthy controls	30	7.17±3.2	
BP response to SHG			
Controlled diabetes	30	10.83±7.29	<0.001
Healthy controls	30	17.47±3.36	

HbA1c: Glycated hemoglobin, BP: Blood pressure, SHG: Sustained handgrip, SD: Standard deviation

BP response to SHG

Mean and SD of BP response to SHG in patients with uncontrolled diabetes, patients with controlled diabetes, and healthy controls are given in Table 1 which are 9.33 ± 4.908, 10.83 ± 7.297, and 17.47 ± 3.360, respectively. When patients with uncontrolled diabetes are compared with patients with controlled diabetes (Table 2), the difference in the mean was statistically insignificant ($P = 0.35$) when uncontrolled diabetes patient group was compared with healthy controls (Table 3) difference in the means was statistically significant ($P < 0.001$). In Table 4, patients with controlled diabetes are compared with healthy controls the difference in the means was statistically significant.

DISCUSSION

In the present study, the prevalence of deranged postural tachycardia index was 90% in uncontrolled diabetes patient group as compared to 40% and 33% in controlled diabetes patient group and healthy controls group, respectively, and the difference in the means of uncontrolled diabetes patient group and controlled diabetes patient group was statistically significant. Orthostatic hypotension or abnormal BP response to standing was found in 30% of patients with uncontrolled diabetes, 30% of patients with controlled diabetes, and only 10% of healthy controls. 93% of uncontrolled diabetes patient had abnormal value of BP response to SHG as compared to 73% and 16% in controlled diabetes patient group and healthy controls group, respectively. Means of BP response to standing and BP response to SHG showed no statistical significance between uncontrolled and controlled diabetes patient groups. It means there is a significant increase in fall in BP on standing in patient with uncontrolled diabetes compared to controls. Value of fall in BP is more in both patient with controlled and uncontrolled diabetes but compared to controls value is greater in patient with uncontrolled diabetes. Increase in DBP to SHG was significantly reduced in both patients of diabetes with good control and those with poor control.

Jayabal et al. studied autonomic function test in patients with Type II diabetes and healthy controls and found statistically significant difference between the means of BP response to SHG. Prasad et al. studied cardiac autonomic dysfunction and ECG abnormalities in patients with Type II diabetes and found increased frequency of postural hypotension in patients with diabetes compared to healthy controls. Finding of the present study is in accordance with studies done by Jayabal et al.[4] and Prasad et al.[5] studies done in the past by Ewing et al.,[6] Dyrberg et al.,[7] Popovic et al.,[8] Beylot et al.,[9] and Barkai and Madacsy[10] had similar results. It can thus be concluded that the heart rate response to standing, a measure of cardiac parasympathetic function is reduced in uncontrolled diabetes patient groups compared to controls. Parasympathetic fibers are affected first due to atherosclerotic changes of vasa nervosum. Decreased blood flow to nerves in diabetes is associated with a decreased contribution of nitric oxide to basal vascular tone.[11]

Besides comparing the value of autonomic function test between patient with diabetes and healthy controls, the present study also shows impact of glycemic control on autonomic function test. Limitation of present study is small sample size. Studies with larger sample size are urgently needed in this region to evaluate autonomic dysfunction in patients with Type II diabetes.

CONCLUSION

Poor glycemic control leads to impairment of cardiovascular response to change in posture and SHG in patients with Type II diabetes mellitus. These tests should be used in outpatient as well as inpatient department routinely for the early detection of autonomic dysfunction and prevention of cardiovascular morbidity and mortality in patients with Type II diabetes mellitus.

REFERENCES

1. Joslin EP, Kahn CR. Joslin's Diabetes Mellitus. 14th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2005. p. 331.
2. World Health Organization. Global Report on Diabetes. Geneva: World Health Organization; 2016.
3. American Diabetes Association. Standards of medical care in diabetes 2011. Diabetes Care. 2011;34 Suppl 1:S11-61.
4. Jayabal M, Thangavel D, Thiyagarajan UM, Ramasamy N, Rangan V, Subramaniyam V. Classical autonomic function tests in patients with Type 2 diabetes mellitus and healthy volunteers: A comparative study. Natl J Physiol Pharm Pharmacol. 2015;5(1):68-71.
5. Prasad CV, Savery MD, Prasad RV. Cardiac autonomic dysfunction and ECG abnormalities in patients with Type 2 diabetes mellitus: Comparative cross-sectional study. Natl J Physiol Pharm Pharmacol. 2016;6(3):178-81.
6. Ewing DJ, Martyn CN, Young RJ, Clarke BF. The value of cardiovascular autonomic function tests: 10 years experience in diabetes. Diabetes Care. 1985;8(5):491-8.
7. Dyrberg T, Benn J, Christiansen JS, Hilsted J, Nerup J. Prevalence of diabetic autonomic neuropathy measured by simple bedside tests. Br Heart J. 1986;55(4):348-54.
8. Popovic-Pejicic S, Todorovic-Dilas L, Pantelinac P. The role of autonomic cardiovascular neuropathy in pathogenesis of ischemic heart disease in patients with diabetes mellitus. Med Pregl. 2006;59(3-4):118-23.
9. Beylot M, Haro M, Orgiazzi J, Noel G. Abnormalities of heart rate and arterial blood pressure regulation in diabetes mellitus. Relation with age, duration of diabetes and presence of peripheral neuropathy. Diabete Metab. 1983;9:204-11.
10. Barkai L, Madacsy L. Cardiovascular autonomic dysfunction in diabetes mellitus. Arch Dis Child. 1995;73(6):515-8.
11. Kihara M, Low PA. Impaired vasoreactivity to nitric oxide in experimental diabetic neuropathy. Exp Neurol. 1995;132:180-5.

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