Original Article

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Autonomic Variation of Blood Pressure in Middle-Aged Diabetics: A Prospective Study

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Abstract

Introduction: Cardiovascular disease is one of the leading causes of mortality and morbidity in patients having diabetes.

Materials and Methods: 100 middle-aged patients having diabetics attending diabetic outpatient department, King George Hospital, Visakhapatnam were considered for this study. On the basis of age, patients were divided into two groups Group 1 - 36-45 years and Group 2 - 46-55 years. Parameters such as resting blood pressure (BP), body temperature, BP response to standing (orthostatic test), BP response to sustained handgrip were measured.

Results: The mean ± standard deviation of all the parameters above are determined, and results were analyzed. Changes within the groups before and after the tests were analyzed by paired *t*-test. Inter group changes were analyzed by unpaired "*t*" test.

Conclusion: Sympathetic tests have shown significant abnormal responses in diabetics as compared to parasympathetic tests.

Key words: Autonomic, Diabetics, Middle-aged

INTRODUCTION

Diabetes mellitus (DM) refers to a group of common metabolic disorders that share the phenotype of hyperglycemia.[1] Non-insulin-dependent DM occurs mainly in middle-aged and elderly and is much more common than insulin-dependent DM.[2] DM is a global epidemic affecting at least 8.3% of the global population and 371 million people worldwide with a significant proportion (50%) remaining undiagnosed. The number of patients with diabetes in India is currently around 40.9 million and is expected to rise to 101 million by 2030. Cardiovascular disease (CVD) is the leading cause of mortality and morbidity in patients with diabetes, and subsequently, the primary goal of diabetes treatment is to reduce the burden of CVD as well as the vascular complications associated with diabetes.[3]

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Autonomic neuropathies affecting the cardiovascular system cause a resting tachycardia and orthostatic hypotension.[1]

Quantitative autonomic function tests consist of a series of simple non-invasive tests for detecting cardiovascular autonomic neuropathy (CAN).

Autonomic function tests are considered reliable, reproducible, simple, and quick to carry out, and all of them are non-invasive. The present study is undertaken to assess the severity of adverse effects of diabetes on autonomic functions of the cardiovascular system which helps in early detection of CAN in asymptomatic diabetic and there by promotes timely diagnostic and therapeutic intervention.

MATERIALS AND METHODS

Selection of Subjects

100 diabetic patients who belong to the middle-age group of 35-55 years attending the diabetic Outpatient Department in King George Hospital, Visakhapatnam were selected.

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Inclusion Criteria

- Cases of already diagnosed Type II diabetes
- Cases who are in the age group of 35-55 years
- Cases who are attending the diabetic outpatient department in King George Hospital, Visakhapatnam.

Exclusion Criteria

- Patients suffering from cardiac, neuronal, and other endocrinal disorders
- Patients under medications other than oral hypoglycemic.

Methods to Collect the Data

The protocol was explained to the subjects and patients, who volunteered for the present study and informed consent was obtained from each of the participants. The subjects were asked to have light breakfast 2 h before the tests and were instructed not to have coffee, tea, or cola 12 h prior to the tests. The subject was asked to relax in the supine position for 30 min. Blood pressure (BP) was measured with sphygmomanometer by the standard auscultatory Riva-Rocci method.

Materials

Autonomic function tests can be carried out using:

1. Sphygmomanometer
2. Hand grip dynamometer.

Physiological parameters

Resting BP

The resting BP was recorded in the supine position using mercury sphygmomanometer and expressed in mmHg.

Body temperature

The body temperature of the subjects was measured by a mercury thermometer.

Procedure of Autonomic Evaluation

In the early 1970's, two simple non-invasive cardiovascular reflex tests were proposed such as BP response to standing up and BP response to the sustained handgrip. These tests have been widely used in a variety of studies.[4]

BP response to standing (orthostatic test)

The subject was asked to rest in a supine position for 5 min. The resting BP was recorded. The subject was then asked to stand unaided and remain standing unsupported for 3 min. The BP was recorded at 30 s and 3 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. A fall of 30 mmHg or more was defined as abnormal, fall between 11 and 29 mmHg as borderline and fall of 10 mmHg or less was considered normal.

BP response to sustained handgrip

In this test, sustained muscle contraction is measured by a handgrip dynamometer, causes a rise in SBP diastolic BP (DBP) and heart rate. The dynamometer is first squeezed to isometric maximum and then held at 30% maximum for 5 min. BP was recorded in the non-exercising arm five times at 1 min interval during the procedure. The maximum reading of the DBP was taken as the final value. Then, the rise in DBP was calculated by subtracting resting DBP from this value. A rise in DBP of <10 mmHg was defined as abnormal, 11-15 mmHg as borderline and 16 mmHg or more as normal.

Heart rate response to deep breathing, valsalva maneuver, and standing are known as tests to evaluate parasympathetic nervous system pathway, whereas BP response to standing and to sustained handgrip allow the assessment of sympathetic nervous system activity.

Observation and Results

The mean ± standard deviation (SD) of the age of the groups 36-45 years and 46-55 years were found to be 41.125 ± 2.95 and 51.51 ± 2.78, respectively.

The mean ± SD of body temperature of the groups 36-45 years and 46-55 years were found to be 96.74 ± 1.01 and 96.64 ± 2.48, respectively

The mean ± SD of resting SBP and DBP, of the age group 36-45 years is found to be 116.25 ± 13.45 and 76.67 ± 10.90 and of the age group 46-55 years is found to be 123.95 ± 14.43 and 81.18 ± 11.54, respectively.

Tables 1 and 2 are showing BP response to standing (orthostatic test-fall in SBP).

BP response to sustained handgrip has been depicted in Tables 3 and 4.

Age and SBP and DBP in the age group 36-45 years has been shown in Table 5.

BP response to standing and sustained hand grip in the age group 36-45 years has been shown in Table 6.

Table 1: Mean±SD of BP response to standing in the age groups 36-45 years and *t* value and *P* value

BP response to standing in age group 36-45 years			
SBP	**Mean±SD**	***t***	***P***
Resting	116.25±13.45	11.09	0.0001
Standing	104.08±15.82		
Difference	12.17±5.37		

In the age group of 36-45 years, the mean±SD of resting SBP is found to be 116.25±13.45, SBP after standing is 104.08±15.82, and fall in SBP is 12.17±5.37, the difference is statistically significant (*P*=0.0001). SD: Standard deviation, BP: Blood pressure, SBP: Systolic blood pressure

BP response to standing and sustained handgrip before and after the maneuver in the age group of 36-45 years is been shown and reading is given in Table 7.

Age, sex, resting BP of age Group 36-45 years and 46-55 years subjects have been given in Table 8.

BP response to standing and sustained hand grip in the age group 46-55 years is shown in Table 9.

Table 2: Mean±SD of BP response to standing in the age groups 46-55 years and *t* value and *P* value

BP response to standing in age group 46-55 years			
SBP	**Mean±SD**	***t***	***P***
Resting	123.95±14.43	16	0.0001
Standing	109.61±16.49		
Difference	14.34±7.81		

In the age group of 46-55 years, the mean±SD of resting SBP is found to be 123.95±14.43, SBP after standing is 109.61±16.49, and the fall in SBP is 14.34±7.81, the difference is statistically significant (*P*=0.0001). SD: Standard deviation, BP: Blood pressure, SBP: Systolic blood pressure

Table 3: Mean±SD of BP response to sustained handgrip in the age groups 36-45 years and *t* and *P* value

BP response to sustained handgrip in age group 36-45 years			
DBP	**Mean±SD**	***t***	***P***
Resting	76.67±10.90	110.13	0.0001
Handgrip	89.75±12.06		
Difference	13.08±6.32		

In the age group of 36-45 years, the mean±SD of resting DBP is found to be 76.67±10.90 DBP after sustained handgrip is 89.75±12.06 and the rise in DBP is 13.08±6.32, the difference is statistically significant (*P*=0.0001). SD: Standard deviation, BP: Blood pressure, DBP: Diastolic blood pressure

Table 4: Mean±SD of BP response to sustained handgrip in the age groups 46-55 years and *t* and *P* value

DBP	Mean±SD	*t*	*P*
Resting	81.18±11.54	17.82	0.0001
Handgrip	94.70±14.12		
Difference	13.51±6.61		

In the age group of 46-55 years, the mean±SD of resting DBP is found to be 81.18±11.54 DBP after sustained handgrip is 94.70±14.12 and the rise in DBP is 13.51±6.61. The difference is statistically significant (*P*=0.0001). SD: Standard deviation, BP: Blood pressure, DBP: Diastolic blood pressure

Table 5: Age and SBP and DBP in the age group 36-45 years

	Age (in years)	SBP (mmHg)	DBP (mmHg)
Mean	41.125	116.25	76.67
SD	2.95	13.45	10.90
SEM	0.60	2.75	2.23

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SD: Standard deviation, SEM: Standard error of mean

BP response to standing and sustained handgrip before and after the maneuver in the age group of 46-55 years (Table 10).

Table 6: BP response to standing and sustained hand grip in the age group 36-45 years

	Fall in SBP (mm Hg)	Rise in DBP (mmHg)
Mean	12.17	13.08
SD	5.37	6.32
SEM	1.10	1.29

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SD: Standard deviation, BP: Blood pressure

Table 7: BP response to standing and sustained handgrip before and after the maneuver in the age group of 36-45 years

	SBP (mmHg)	SBP to standing (mmHg)	Fall in SBP (mmHg)	DBP (mmHg)	DBP to handgrip (mmHg)	Rise in DBP (mmHg)
Mean	116.25	104.08	12.17	76.67	89.75	13.08
SD	13.45	15.82	5.37	10.90	12.06	6.32
SEM	2.75	3.23	1.10	2.23	2.46	1.29

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SD: Standard deviation, BP: Blood pressure

Table 8: Age and resting BP in the age group 46-55 years

	Age (in years)	SBP (mmHg)	DBP (mmHg)
Mean	51.51	123.95	81.18
SD	2.78	14.43	11.54
SEM	0.32	1.66	1.32

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SD: Standard deviation, BP: Blood pressure

Table 9: BP response to standing and sustained hand grip in the age group 46-55 years

	Fall in SBP (mm Hg)	Rise in DBP (mmHg)
Mean	14.34	13.51
SD	7.81	6.61
SEM	0.90	0.76

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SD: Standard deviation, BP: Blood pressure

Table 10: BP response to standing and sustained handgrip before and after the maneuver in the age group 46-55 years

	SBP (mmHg)	SBP to standing (mmHg)	Fall in SBP	DBP (mmHg)	DBP to handgrip (mmHg)	Rise in DBP
Mean	123.95	109.61	14.34	81.18	94.70	13.51
SD	14.43	16.49	7.81	11.54	14.12	6.61
SEM	1.66	1.89	0.90	1.32	1.62	0.76

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SD: Standard deviation, BP: Blood pressure

The abnormal BP response to standing in the subjects may be due to vagal damage as a part of diabetic autonomic neuropathy (Table 11).

DISCUSSION

BP Response to Standing

- In the present study, the mean SBP was found to be decreased in all the groups from lying down to one minute after standing which was statistically significant. The fall was due to decrease venous return and decreased cardiac output on standing affected by gravity.[4]

In their study on 50 diagnosed cases of DM Chugh *et al.*, in 2011, titled "QT dispersion in patients of DM without manifest cardiac dysautonomia," they found that 2 subjects showed an abnormal response, and 10 subjects were found to have a borderline response of BP to standing.

In 2014, Prakash *et al.* studied 100 diabetic patients matched against 50 normal healthy controls in their study titled "A cross-sectional study for the evaluation of autonomic nervous system functioning in Type 2 DM patients." When the BP response to supine to standing was evaluated, there was a significant decrease in SBP among controls and cases ($P < 0.05$).[5,6]

Chavan *et al.*, in 2009, in their study titled "determination of sensitivity among various cardiovascular autonomic function tests in diabetic patients of Bijapur" recruited 11 diagnosed diabetic patients and 15 healthy age-matched controls. Subjects were subjected to six standardized cardiovascular autonomic reflex function tests. Only one diabetic subject has shown abnormal response, and four subjects have shown borderline response of BP to standing.[7]

Caird *et al.*, in 494 people of aged 65 years or more living at home, have found drop of 20 mmHg or more in systolic pressure occurred on standing in 24%, 30 mmHg or more in 9% and of 40 mmHg or more in 5 % in their study on "Effect of posture on BP in the elderly.[8]

Table 11: Percentage distribution of cases according to age groups in normal, borderline, and abnormal patterns in BP response to standing

	Fall in SBP			
Age group (years)	Total (%)	Normal (%)	Borderline (%)	Abnormal (%)
36-45	24 (100)	14 (58.3)	10 (41.7)	0 (0)
46-55	76 (100)	39 (51.3)	32 (42.1)	5 (6.6)

SBP: Systolic blood pressure, BP: Blood pressure

In a study on "effect of posture on BP in elderly patients" by Spalding J.M.K, Johnson R.H, Smith A.C, and Wollner L. have observed a fall in SBP of more than 20 mmHg in 11 patients after they had sat 5 min and in 17 patients after they had stood for 2 min. The maximum fall was 60 mmHg (SBP) on standing, and several patients felt dizzy on sitting as well as standing. All patients with fall in SBP of over 20 mmHg had evidence of CVD.[9]

Kempler *et al.*, have concluded that a fall of more than 20 mmHg in SBP after standing up seemed to be most reliable criterion for the assessment of orthostatic hypotension in the diagnosis of autonomic neuropathy in patients with Type-I DM in a study involving 3007 randomly selected Type-I diabetic patients on BP response to standing in diagnosis of autonomic neuropathy: The EURODIAB IDDM complications study.[10]

V. BP response to sustained handgrip.

The values of mean ± SD for both the age groups are given in Tables 3 and 4.

The statistical analysis: The values of paired "*t*" test and "*P*" value are given in Tables 3 and 4, respectively.

Chavan *et al.*, in 2009, in their study titled "Determination of sensitivity among various cardiovascular autonomic function tests in diabetic patients of Bijapur" recruited eleven diagnosed diabetic patients and fifteen healthy age-matched controls. Subjects were subjected to six standardized cardiovascular autonomic reflex function tests. Three diabetic subjects have shown abnormal response where the rise in BP was <10 mmHg and four subjects have shown borderline response of BP to standing.[7]

In their study on 50 diagnosed cases of DM Chugh *et al.*, in 2011, titled 'QT dispersion in patients of DM without manifest cardiac dysautonomia," they found that 4 subjects showed abnormal response and 9 subjects were found to have borderline response of BP to sustained handgrip.[6]

In a study on "acupuncture effects on autonomic response to cold pressor and handgrip exercise in healthy humans" by Holly R. M, Janki B.S, Jun Liang Yu Katit Hui, in 2004, found that in normal healthy human, acupuncture at P6, LIV 3, and LI 4 does not attenuate the BP or heart rate response during handgrip exercise or cold pressor test.[11]

CONCLUSION

Involvement of nervous system is a well-known complication of diabetes. Neuropathy is one of the most common complications of diabetes. At an early

stage, autonomic dysfunction may be asymptomatic or mildly symptomatic. Symptomatic autonomic neuropathy carry worst prognosis, so early diagnosis is essential for maximum benefit. More sympathetic tests have shown significant abnormal responses in diabetics compared to parasympathetic tests. Probably no single test suffices indicating normality or autonomic neuropathy in diabetics, and a battery of tests reflecting both parasympathetic and sympathetic functions is preferable.

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