

Correlates of SDNN heart rate variability in healthy subjects and subjects with type 2 diabetes mellitus

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Abstract

Introduction: Standard deviation of R-R intervals (SDNN) predicts mortality in variety of clinical conditions. But little is known about correlates of SDNN.

Objective: To investigate correlates of SDNN in healthy subjects and with type 2 diabetes.

Materials and Methods: 115 male subjects with type 2 diabetes and 87 controls were studied. In them heart rate (HR), blood pressure (BP), body mass index (BMI), Q-Tc and SDNN were measured. Pearson correlation coefficient and unpaired t test were used for data analysis. $P < 0.05$ was considered significant.

Results: In controls, SDNN was negatively correlating with age and HR ($p < 0.05$, < 0.001 respectively). In subjects with type 2 diabetes, SDNN was negatively correlating with HR, diastolic blood pressure, Q-Tc and duration of diabetes ($p < 0.0001$, < 0.01 , $= 0.014$, < 0.05 respectively); and was positively correlating with BMI ($p < 0.05$).

Conclusion: Higher HR, DBP, prolonged Q-T interval and duration of diabetes are associated with reduced SDNN in subjects with type 2 diabetes. In them BMI could be a confounding factor while assessing cardiac autonomic dysfunction employing SDNN. In healthy subjects high HR and age are associated with reduced SDNN.

Keywords: SDNN, heart rate, Q-Tc, blood pressure, duration of diabetes

1.Introduction

Indices of heart rate variability (HRV) provide insight into cardiac autonomic control.[1] The simplest technique of measuring HRV is the standard deviation of the time series of time intervals between consecutive heart beats (SDNN).[1]

Low SDNN is associated with high risk of sudden death in myocardial infarction patients.[2][3] Depressed SDNN is reported to be an independent risk factor for a poor prognosis in patients with congestive heart failure.[4] Some researchers have also reported that SDNN predicts mortality from all causes in middle-aged and elderly men.[5][6] A study on progression of cardiac autonomic dysfunction in type 2 diabetes has reported that SDNN could be a

suitable marker in quantifying cardiac autonomic dysfunction in relation to cardiovascular disease in type 2 diabetes.[7] Reduced heart rate responses to deep breathing is also associated with sudden unexplained deaths.[8][9] Thus identifying the correlates of SDNN along with E:I ratio may aid in early detection and management of risk factors associated with cardiac autonomic dysfunction related mortality in subjects with type 2 diabetes mellitus.

2. Materials and methods

The Study group was comprised of 115 male patients clinically diagnosed with type 2 diabetes based on ADA criteria. They were unselected with

regard to diabetes related complications and treatment. The Control group was comprised of 87 non-diabetic healthy male subjects matched for age of study subjects. This study was undertaken after the approval by the Institutional Ethical Committee and obtaining consent from the study participants.

Cardiac autonomic function was assessed by quantifying the following parameters: Expiratory: Inspiratory ratio (E: I ratio), standard deviation of all the R–R Intervals (SDNN) heart rate (HR) and Q-Tc. In addition, in all the subjects the height, weight and blood pressure was measured. The body mass index (BMI) was calculated using the formula: weight in kilograms (kg) divided by height in meters (m) squared.

2.1 Assessment of Expiratory: Inspiratory ratio (E: I ratio) in response to deep breathing:

This test was performed in the morning after subjects were completely relaxed. Before beginning the test, subjects were taught to breathe, at six breaths per minute: five seconds for each inhalation and five seconds for each exhalation. The examiner raised her hand to signal the start of each inhalation and lowered to signal the start of each exhalation Lead II electrocardiogram was then recorded continuously at a speed of 25 mm/s for 60 s while the subject breathed as instructed. The R–R intervals were measured accurately. The longest interval during expiration and the shortest R–R interval during inspiration were expressed as E: I ratio.[10]

2.2 Assessment of SDNN

SDNN was estimated from one minute resting lead II electrocardiogram tracing in supine position in completely relaxed state. All the R–R intervals were measured accurately and fed into a computer. SDNN was then estimated with appropriate statistical functions using Microsoft Windows XP Professional.

2.3 Assessment of heart rate (HR)

The HR was obtained from counting total number of R–R intervals in one minute

electrocardiogram recorded in lead II in supine position in completely relaxed state.

2.4 Assessment of QTc:

Q–T intervals and the preceding R–R intervals were measured from the electrocardiogram tracing in lead II in supine position. Q–T interval was defined as the first deflection of the QRS complex and the end as the point of maximal change in the slope as the T wave merges with the baseline. QTc was calculated according to Bazett's formula: QTc = measured QT/square root of the R–R interval.[11]

2.5 Statistical analysis

Data was analyzed by suitable statistical tests namely Unpaired 't' test, Mann-Whitney 'U' test and Pearson Correlation Coefficient test. $P < 0.05$ was taken as statistically significant.

3. Results

In the study subjects, the mean duration of diabetes was 8.90 ± 7.81 years. Their mean fasting blood sugar was 179.67 ± 74.46 . Some of the study subjects were with multiple complications. None of them had cardiomyopathy. 27 of the study subjects were free from complications (FFC group). 28 were with cardiovascular disease (CVD group) and 18 were with somatic neuropathy alone (PNP group). The comparison of mean \pm SD of SDNN among these three groups were comparable (FFC group = 31.34 ± 11.33 ; CVD group = 26.83 ± 11.46 ; PNP group = 24.77 ± 13.57 ; F value = 1.844, $p = 0.66$). E: I ratio was significantly lower in PNP group compared to FFC and CVD groups (FFC = 1.404 ± 0.17 ; CVD = 1.37 ± 0.16 ; PNP = 1.17 ± 0.06 ; $p < 0.001$).

The comparison of baseline characteristics between healthy males and males with type 2 diabetes is presented in table 1. The HR, systolic (SBP) and diastolic blood pressure (DBP) was significantly higher in study subjects compared to controls (table 1). E: I ratio was significantly lower in study group compared to controls (table 1). Age, BMI, Q-Tc and SDNN were comparable between study group and controls.

Table 1: Comparison of baseline characteristics between controls and study group

variables	Controls (n = 87)	Study group (n = 115)	P value
Age (years)	53.92 ± 10.58	56.21 ± 10.12	0.11
Body mass index (kg/m^2)	23.1 ± 3.08	22.56 ± 2.94	0.2
Systolic blood pressure (mmHg)	124.66 ± 9.15	139.46 ± 14.87	< 0.0001
Diastolic blood pressure (mmHg)	81.01 ± 4.43	85.53 ± 9.06	< 0.0001
Heart rate (beats/min)	78.44 ± 8.58	85.37 ± 10.99	0.0005
E:I ratio	1.43 ± 0.11	1.31 ± 0.12	< 0.0001
Q-Tc (milliseconds)	0.38 ± 0.01	0.38 ± 0.03	0.58
SDNN (milliseconds)	29.30 ± 11.69	27.19 ± 11.90	0.20

n = sample size; NS= Non-significant; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 2: Correlation between SDNN and characteristics of controls and study subjects

variables	Controls (n= 87)	Study group (n =115)
Age (years)	-0.2248*	-0.1523 ^{NS}
Duration of diabetes	-----	-0.2169 *
Body mass index (kg/m ²)	0.08901 ^{NS}	0.2298*
Systolic blood pressure (mmHg)	-0.0833 ^{NS}	-0.104 ^{NS}
Diastolic blood pressure (mmHg)	-0.1258 ^{NS}	-0.2211*
Heart rate (beats/minute)	-0.3136**	-0.3962***
Q-Tc (milliseconds)	0.06042 ^{NS}	-0.2745**
E:I ratio	0.2503*	0.394***

n= sample size; NS= Non-significant; * p < 0.05; ** p < 0.01; *** p<0.001

In the study group SDNN was significantly negatively correlating with duration of diabetes, HR, DBP and Q-Tc (Table 2). SDNN was positively correlating with E: I ratio and BMI (Table 2). SDNN was not correlating with age and SBP (Table 2). In controls SDNN was negatively correlating with age and HR (Table 2). SDNN was positively correlating with E: I ratio (Table 2). SDNN was not correlating with BMI, BP and Q-Tc (Table 2).

In the study group E: I ratio was significantly negatively correlating with age, duration of diabetes, HR and Q-Tc. E: I ratio was positively correlating with SDNN and BMI. There was no significant correlation between E: I ratio and BP (Table 3).

In controls, E: I ratio was negatively correlating with age and HR (Table 3). E: I ratio was not correlating with BMI, BP and Q-Tc (Table 3).

Table 3: Correlation between E:I ratio and studied clinical characteristics in controls and study subjects

Variables	Healthy Males (n = 87)	Diabetic males (n =115)
Age (years)	-0.2627 *	-0.5201***
Duration of diabetes	-----	-0.4422 ***
Body mass index (kg/m ²)	-0.0531 ^{NS}	0.3358 ***
Systolic blood pressure (mmHg)	-0.08617 ^{NS}	-0.1672 ^{NS}
Diastolic blood pressure (mmHg)	-0.1671 ^{NS}	-0.0545 ^{NS}
Heart rate (beats/minute)	0.09666 ^{NS}	-0.253 **
Q-Tc (milliseconds)	-0.0739 ^{NS}	-0.3028 **
SDNN (milliseconds)	0.2503*	0.394***

n= sample size; NS= Non-significant; * p < 0.05; ** p < 0.01; *** p<0.001

4. Discussion

In the present study, positive correlation was observed between SDNN and E: I ratio in controls and study group. In study subjects E: I ratio and SDNN were negatively correlating with HR, Q-Tc, duration of diabetes; and positively correlating with BMI (Table 2 and 3). Heart rate response to deep breathing is predominantly mediated through parasympathetic activity.[9] BMI is a measure of general body fat and Q-T interval is a measure of duration of ventricular action potential. Thus it could be said that SDNN reflects parasympathetic activity related to general body fat, HR and ventricular action potential mainly in type 2 diabetes.

In this study, in the study group, SDNN was negatively correlating with DBP (Table 2). Peripheral resistance is the major determinant of DBP. Peripheral resistance in turn is largely determined by arteriolar diameter which is under the control of sympathetic activity.[12] The SDNN reflects all the cyclic components responsible for variability in the period of recording and is regarded to reflect both the sympathetic and the

parasympathetic influence on HRV.[13] Therefore we speculate that negative correlation observed between SDNN and DBP could be due to decreased parasympathetic activity owing to sympathetic over activity related to diabetes induced alteration in autonomic cardiovascular control.

The effect of ageing on HRV is well known.[14][15][16] In this study in the study and control groups E: I ratio was negatively correlating with age (Table 3). On the other hand, correlation between SDNN and age was observed only in controls (Table 2). Therefore it could be suggested that E:I ratio could be a better marker in assessing age related changes in cardiac autonomic function.

Our study is with certain limitations. Correlation of SDNN and E:I ratio with continues variables were investigated in study subjects unselected with regard to diabetes related complications and mode of treatment. We did not analyze the data separately in subgroups of study subjects based on complications owing to relatively small sample size of these subgroups. However SDNN was comparable among study subjects free

from complications, subjects with cardiovascular disease and somatic neuropathy alone.

5. Conclusion

Higher HR, DBP and prolonged Q-T interval and duration of diabetes are associated with reduced SDNN in male subjects with type 2 diabetes. In them BMI could be a confounding factor in assessing cardiac autonomic dysfunction employing SDNN. In healthy male subjects high HR and age are associated with reduced SDNN.

Conflict of interest

The authors declare that they have no conflict of interest.

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