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FREQUENCY DOMAIN ANALYSIS OF HEART RATE VARIABILITY IN TYPE II DIABETES MELLITUS: A COMPARATIVE STUDY

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ABSTRACT

Objectives: To assess the cardiac autonomic function status in type II Diabetes Mellitus patients by Heart Rate Variability (HRV). This study is also to know the importance of 5 minutes HRV for the detection of autonomic dysfunction in type II DM.

Methods: 50 diabetics and 50 non- diabetics of age group 40-60 years were selected as test and control groups respectively. Computerized ECG system with the PhysioPac 4-channel software was used for the study. Frequency domain measures such as very low frequency (VLF), low frequency (LF), high frequency (HF) and LF/HF ratio were assessed.

Results: Statistical analysis was done by SPSS software with Student's t-test. Frequency domain parameters such as LF and LF/HF ratio were significantly (< 0.05) reduced in diabetics compared to controls.

Conclusion: HRV was significantly decreased in diabetics compared to controls. The benefits of an HRV evaluation in assessing and monitoring the severity of diabetes mellitus should be further studied. The earlier we are diagnosed, the more can be done to improve the outcome and avoid Cardiac Autonomic Neuropathy.

KEYWORDS : Heart Rate Variability; Diabetes Mellitus; Cardiac Autonomic Neuropathy; Frequency Domain.

INTRODUCTION

Diabetes mellitus (DM) can cause multisystem complications, mainly in the kidney, eye, heart and the nervous system. The International Diabetes Federation estimates that approximately 4.6 million diabetes-related deaths occur every year. By 2030, about 80 to 87 million people of India will be diabetic and 438 million people of the adult population are expected to have diabetes worldwide. The prevalence of DM affecting mainly urban population for all age groups worldwide was estimated to be 4.4% in 2030.[1-4]

Autonomic nervous system dysfunction is one of the significant complications of diabetes mellitus that is generally associated with a poor prognosis. Screening for cardiac autonomic neuropathy has been recommended at the diagnosis of type II diabetes mellitus. Heart rate variability (HRV) is the variation in the time intervals between adjacent heartbeats. The heart-brain interactions and autonomic nervous system (ANS) processes generate HRV. The regulation of autonomic balance, blood pressure, gas exchange, heart and vascular tone can be reflected by HRV. The spectral analysis of HRV is an easy-to-perform and non-invasive tool for assessing cardiac autonomic activity. The measurement of HRV is non-intrusive and pain-free. Although the evaluation of HRV in diabetes mellitus has been assessed in several studies, conflicting results have been reported. Therefore, low HRV is a marker of cardiovascular risk.[5-10]

MATERIALS AND METHODOLOGY:

Approval of the Institutional ethics committee was taken before conducting the study. This case-control study was carried out from March 2017 to July 2018 (1 year 5 months). This study was done on 100 subjects (50 diabetic patients from Yenepoya Medical College Hospital, Yenepoya University, Mangalore and 50 healthy adult subjects from general population of Mangalore) in the age group of 40-60 years.

Inclusion Criteria:

·Diabetic subjects aged between 40 and 60 years of both genders.
·Non-diabetic subjects aged between 40 and 60 years of both genders were selected as control group.

Exclusion Criteria:

·Individuals who declined for informed consent.
·Type I Diabetes Mellitus
·Pregnancy.
·Individuals with hypertension, congestive cardiac failure, symptomatic coronary artery disease and atrial fibrillation.
·Individuals who had any symptoms of neuropathy.
·Individuals with psychological and other endocrinal disorders.
·Individuals taking medications or drugs that could affect cardiovascular functions.

Their height, weight, Body Mass Index (BMI) and blood pressure (BP) were recorded. A general physical examination including vital signs was recorded. Subjects were asked to have only a light breakfast at least 2-3 hours prior to the study for the recording done in the morning. The room temperature was made constant for all recordings. The subjects were asked to avoid coffee, tea or any soft drinks at least 1 hour prior to recording. Smoking and alcoholic subjects were excluded from the study. The patient was not disturbed throughout the recording.

Recording of Heart Rate Variability (HRV):

The subject was asked to sit comfortably for 5 minutes. BP was recorded. The ECG electrodes were placed on the limbs of the subject and the leads connected to the machine for lead II ECG recording. Acquiring the ECG signals using a data acquisition system such as PHYSIOPAC 4-channel (MEDICAID SYSTEM, Chandigarh) was done. Transferring of data was done from PHYSIOPAC to a Windows-based PC loaded with software for HRV analysis. The ectopics and artefacts if present were removed from the recorded ECG. Extraction of the R-R tachogram was done using the R wave detector, which was later used offline for short term HRV analysis (the R-R tachogram should have a minimum of 288 R-R intervals). HRV analysis was performed using the HRV Analysis Software version 1.1 (Biomedical Signal Analysis Group, Department of Applied Physics and University of Kuopio, Finland). The frequency domain parameters such as TP, LF, HF, LF nu, HF nu and LF/HF ratio were calculated.[11]

STATISTICAL ANALYSIS

Results are expressed as mean ± SD. Difference between the groups was tested by using SPSS software with Student's t-test. P value <0.05 was considered as statistically significant.

RESULTS

Mean value ± SD of frequency domain parameters of HRV are depicted in Table 1. Mean VLF (Hz) was 0.015 ± 0.01 and 0.016 ± 0.01 in controls and diabetics respectively (p>0.05). Mean VLF (ms^2) was 2268.36 ± 328.78 and 2260.92 ± 486.03 in controls and diabetics respectively (p>0.05).

Mean LF (Hz) was 0.08 ± 0.03 and 0.06 ± 0.04 in controls and diabetics respectively (p<0.05). Mean LF (ms^2) was 1279.64 ± 655.90 and 757.12 ± 250.51 in controls and diabetics respectively (p<0.05). Mean LF (n.u.) was 52.39 ± 14.78 and 41.76 ± 11 in controls and diabetics respectively (p<0.05).

Mean HF (Hz) was 0.30 ± 0.12 and 0.25 ± 0.15 in controls and diabetics respectively (p>0.05). Mean HF (ms^2) was 339.34 ±

181.60 and 349.02 ± 163.07 in controls and diabetics respectively (p>0.05). Mean HF (n.u.) was 45.45 ± 18.19 and 49.67 ± 15.52 in controls and diabetics respectively (p>0.05).

Mean LF / HF ratio was 1.60 ± 0.79 and 0.90 ± 0.36 in controls and diabetics respectively (p<0.05).

Table 1: Comparison of frequency domain parameters of HRV between controls and diabetics.

Parameters	Controls (Mean ± SD)	Diabetics (Mean ± SD)	p- value
VLF (Hz)	0.02 ± 0.01	0.02 ± 0.01	0.538
LF (Hz)	0.08 ± 0.03	0.06 ± 0.04	0.001*
HF (Hz)	0.30 ± 0.12	0.25 ± 0.15	0.079
VLF (ms^2)	2268.36 ± 328.78	2260.92 ± 486.03	0.929
LF (ms^2)	1279.64 ± 655.90	757.12 ± 250.51	0.00*
HF (ms^2)	339.34 ± 181.60	349.02 ± 163.07	0.78
LF (n.u.)	52.39 ± 14.78	41.76 ± 11.20	0.00*
HF (n.u.)	45.45 ± 18.19	49.67 ± 15.52	0.215
LF/ HF	1.60 ± 0.79	0.90 ± 0.36	0.00*

*** Significant (p-value<0.05)**

DISCUSSION

Diabetes mellitus is a chronic disease that occurs when the pancreas is no longer able to make insulin, or when the body cannot make good use of the insulin it produces.

In a normal individual, a high degree of beat-to-beat variability in heart rate is seen and HRV changes with respiration increasing on inspiration and decreasing on expiration. HRV denotes the autonomic tone of an individual and frequency domain measures are considered as best quantitative method for sympathetic and parasympathetic activity. A predominance of parasympathetic activity causes bradycardia by restoring the vagal flow via the release of acetylcholine and increase beat-to-beat variation, whereas increased sympathetic tone induces tachycardia as a result of cardiovascular center inhibiting vagal outflow and reduce beat-to-beat variations in HRV.[12]

In this study, there was a statistically significant reduction in all the mean values of LF and LF/HF ratio in diabetic subjects compared to the controls. But there was no statistically significant change in the mean values of VLF and HF between diabetics and controls.

HRV tests of cardiac parasympathetic and sympathetic activity were significantly lower in diabetics compared to the controls. This study demonstrated that diabetics had both cardiac sympathetic and cardiac parasympathetic nervous system involvement. The findings of present study showed a significant decrease in LF values in diabetics compared to non-diabetic subjects which was in support to the study conducted by Sucharitha S et al. in 2011. Although the present study had decrease in mean values of HF power, there were no statistically significant reduction in any of the mean values of HF in diabetics compared to controls. [13]

The present study found that there was reduction in high frequency values in diabetics but it was not statistically significant compared to controls. High frequency usually measures the parasympathetic activity and the present study showed there was reduction in parasympathetic activity in diabetics. These findings were in consistent with the findings of the studies designed by Gerritsen J et al. and Kudat H et al. respectively. [14,15]

LF/HF ratio is a measure or a marker of "sympatho-vagal balance" as mentioned in studies conducted by Pagani M et al. This study showed there was sympatho-vagal imbalance in diabetic subjects compared to controls. The findings in our study was consistent with the study conducted by Mirza M et al. , in which LF and LF/HF ratio were significantly reduced in diabetics compared to normal individuals.[16-18]

CONCLUSIONS

Frequency domain measures of HRV test can be done effectively for physiological and clinical investigations in the field, by the patient's bed side, or in the laboratory using more elaborate equipment. Physiologists, clinicians and medical students can make use of these tests to assess the cardiovascular autonomic tests, thereby preventing cardiovascular complications including Cardiac Autonomic Neuropathy (CAN) and Diabetic Autonomic Neuropathy (DAN).

This study shows that HRV is significantly reduced in diabetic patients compared to controls. Since reduced HRV is associated with cardiac arrhythmias, suggesting that these diabetic patients may have risk for occurrence of cardiac arrhythmias and even cardiac arrest. Impaired cardiac autonomic function was characterized by sympathetic over activity in diabetics and also showed that the sympatho-vagal balance in diabetic patients is towards higher sympathetic and lower vagal modulation. HRV was significantly decreased in diabetic patients when compared to non-diabetics who were not having any symptoms of neuropathy. Therefore, HRV test proves to be an important tool for the early detection of neuropathy in type II diabetes.

The benefits of an HRV evaluation in assessing and monitoring the severity of diabetes mellitus should be further studied, given its potential as a non- invasive, reliable and pain-free measurement. Early detection of neuropathy will improve the awareness of the patients. The progress into overt disease can hence be prevented using better glycemic control and taking appropriate drugs or with the start of insulin. The earlier we are diagnosed, the more can be done to improve the outcome and avoid CAN and DAN.

INTEREST OF CONFLICT

The authors declare no conflict of interest.

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