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A Study Of Heart Rate Variability In Of Type 2 Diabetes Mellitus

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Abstract

Background: Diabetic parents have an increased risk of developing diabetes especially if both parents are diabetic. Heart rate variability is a noninvasive, sensitive method to analyze autonomic dysfunctions for assessment of sympathovagal balance. By conducting this research study cardiac autonomic dysfunction can be found in diabetic and patients without diabetes.

Aim And Objective: To analyze HRV in 30 Type 2 Diabetes Mellitus who are not diabetics and serve as a control group. This HRV analysis is compared with 30 Type 2 Diabetes Mellitus who diabetics serve as a test group.

Materials And Methods: This Single-center, nonrandomized, observational study was conducted in the department of cardiology, government Mohan Kumar Mangalam medical college, Salem, Tamil Nadu, India in the year 2020-2021. After taking informed consent, a sample size of 60 Type 2 Diabetes Mellitus was analyzed for HRV analysis within the age group of 30 – 70 years males and females were recruited. 5-minute Lead II E.C.G was acquired using the R.R. Interval in time and frequency domain measures and R.R. Tachogram was plotted. Comparison of HRV with other parameters like lipid profile, blood glucose, glycosylated hemoglobin, B.M.I was found out between the test and control groups.

Results: The mean value of the heart rate was decreased in the study group and the difference was found to be statistically significant with a p-value of 0.01. The mean $\pm$ SD values of mean H-R in beats per minute in the control group was 74.51$\pm$13.55 and in the study group was it 83.33 $\pm$14.73 beats per min. The mean value of the heart rate was increased in the study group and the difference was found to be statistically significant with a p-value of 0.02. The mean value of the SDNN was decreased in the study group and the difference was found to be statistically insignificant with a p-value of 0.17. The mean + SD values of RMSSD (ms) in the control groups were was25.77+ 17.16 and in the study group was 15.99 + 7.73. There was a decrease in the mean value of RMSSD in the study group. The difference was found to be statistically significant with a value of 0.01. The mean $\pm$ SD values of pNN50 (ms) in the control groups were was3.69 $\pm$ 5.31 and in the study group was 0.85 $\pm$ 1.84. There was a decrease in the mean value of pNN50 in the study group. The difference was found to be statistically significant with a p-value of 0.01difference was found to be statistically significant with a p-value of 0.01.

Conclusion: In my study, it indicates decreased parasympathetic activity. This sympathovagal imbalance can be prevented by lifestyle modification. Otherwise, these people may be affected by complications of Diabetes Mellitus.

Keywords: Sympathovagal Imbalance, Heart rate variability (HRV), Diabetes Mellitus.

Introduction

According to the International Diabetes Federation (2010), at least 285 million people in the world have been affected by diabetes and the number might escalate to 438 million by the year 2030. Out of this two thirds will be from low to middle-income countries[1,2.3] The risk factors associated with diabetes are stress, insulin resistance, increased body mass index, family history of diabetes, physical inactivity, and sedentary lifestyle habits. Heart rate variability measures the time taken between heartbeats and is an effective tool in assessing the autonomic function of the heart.[4] HRV analysis is a noninvasive method of assessing cardiac activity and autonomic nervous system status which is responsible for regulating cardiac activity. HRV is most effective in monitoring the autonomic nervous system (ANS).[13] To maintain homeostasis of the cardiovascular system, interactions between the sympathetic and parasympathetic nervous system becomes integral.[5] The balancing action of the sympathetic nervous system and parasympathetic nervous system plays a pivotal role in controlling heart rate. Sympathetic over-activity increases heart rate and reduces cyclical beat-to-beat variation, on the other hand, parasympathetic over-activity decreases heart rate and increases beat-to-beat variation. [6]Heart rate fluctuations around the mean heart rate reflect the status of the cardiorespiratory control system. HRV is an important tool for monitoring the post-infarction condition of diabetic patients.[7] HRV is a tool for measuring neurocardiac functions that reflects interactions between the heart and the brain and the autonomic nervous system.[8]HRV can measure the autonomic activities through low frequency, an index of sympathetic modulation and high frequency, an index of parasympathetic modulation. HRV analysis helps to evaluate the autonomic cardiac activity in various pathophysiologic conditions. Any impairment in heart rate variation is considered to be a marker of autonomic neuropathy in diabetic subjects.[9] Heart rate variability serves as a marker for the autonomic control of cardiac electrophysiological properties. It also provides information for accurately determining risk factors.HRV analysis is non-invasive, risk-free, easy to perform, and has become an effective and vital tool that provides prognostic information to detect heart diseases. A healthy heart is not static and changes dynamically concerning physiological functions. If the variability of the RR interval is high then the functioning of the heart is good. The mortality related to cardiac disorders may rise due to increased sympathetic overactivity and parasympathetic hypoactivity. [10]

Materials And Methods: This Single-center, nonrandomized, observational study was conducted in the department of cardiology, government Mohan Kumar Mangalam medical college, Salem, Tamil Nadu, India in the year 2020-2021. After taking informed consent, a sample size of 60 Type 2 Diabetes Mellitus was analyzed for HRV analysis within the age group of 30 – 70 years males and females were recruited. 5-minute Lead II E.C.G was acquired using the R.R. Interval in time and frequency domain measures and R.R. Tachogram was plotted. Comparison of HRV with other parameters like lipid profile, blood glucose, glycosylated hemoglobin, B.M.I was found out between the test and control groups. Exclusion Criteria: Hypertension, Chronic kidney disease, Rheumatoid arthritis, Any cardiac illness, Bronchial asthma, The blood parameters like fasting blood glucose, postprandial blood glucose, lipid profile status, and HbA_1c values were collected. Other physiological variables like sex, height, the weight of the individual, duration of diabetes, and age of onset will also be noted. The body mass index is then calculated.HRV can be quantified in the time and frequency domain using the RR intervals in the 5 min lead 2 ECG. The RR- Tachogram is plotted. There are two types of HRV recordings: the short-term 5 minutes HRV recording and day and night long term HRV recording. Though long term HRV recording is the ideal one, short-term HRV recording is usually performed for research and clinical investigations. The procedure of short-term recording is depicted in the Task Force Report on HRV. The subject is asked to lie down comfortably in the supine position in the

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laboratory, and ECG electrodes are connected for lead 2 ECG recording. The positive electrode was connected to the left arm, a negative electrode was connected to the right arm. The ground electrode was connected to the right foot. All the subjects recorded baseline ECG and exclusion of abnormal baseline ECG was done. After 5 minutes of supine rest, ECG signals are acquired at a rate of 1000 samples/ second during supine rest using a data acquisition system, such as BIOPAC MP 100 (BIOPAC INC, USA), (Minimum 250 HZ sampling rate)The raw ECG signals and the RR Intervals are acquired on a moving time base. Data from BIOPAC are transferred to windows – based PC loaded with software for HRV analysis, such as acknowledged software version 3.8.2 Ectopics, and artifacts are removed from the recorded ECG.RR Tachogram is extracted from the edited 256 sec ECG Using the R wave detector in the acknowledged software and saved in ASC- 2 format, which is later used offline for short–term HRV analysis (RR tachogram should have minimum 288 RR intervals)HRV analysis is performed by using the HRV analysis software version 1.1 (Bio- Signal Analysis group, Finland) Heart rate variability is assessed by spectral analysis of an array of RR intervals. The main advantage of spectral analysis of signals is the possibility to study their frequency-specific oscillations. Thus, not only the amount of variability but also the oscillation frequency (number of heart rate fluctuations per second) can be obtained. Applications of different spectral methods were used for the analysis of the RR tachogram. Power Spectral Density (PSD) analysis gives insights into how power variance distribute as the function of frequency.

Statistical Analysis

The statistical analysis was done using SPSS software (statistical package for social science version – 23) by independent sample t-test for comparing the participants of the control group and study group. The descriptive statistics frequency analysis and percentage analysis were used for categorical variables, and the mean and standard deviation were used for continuous variables. All these correlation analyses are carried out by Pearson correlation analysis. In all the above statistical tools the probability value < 0.05 is considered a significant level.

Results

Table - 1 Age Comparison Of Age Between Controls And Cases

	N	Mean	Std.Deviation	P value
Age Control	30	41.3000	10.55413	0.003*
Cases	30	49.5000	10.06102	

Table 1:The age of the 30 controls had a mean and SD of 41.3 + and SD10.55 years. The study group with diabetes had a mean and SD of 49.5 +10.06 years and the difference was found to have a P value of 0.003 which was statistically significant. This shows that the age of both groups is matched in our study. the p-value is 0.003* Statistically significant.

Table – 2:Comparison Of Mean Rr Between Controls And Cases

Mean RR (ms)	Control/ Cases	N	Mean	Std. Deviation	P value
	Control	30	825.6507	152.36813	0.01*
	Cases	30	735.8607	120.02056	

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Table:2The mean + SD values of mean R-R(ms) in the control group was 825.65 +152.37 and in the study group was 735.86+ 120.02(ms). The mean value of the heart rate was decreased in the study group and the difference was found to be statistically significant with a p-value of 0.01.p-value is 0.01,* Statistically significant

Table – 3:Comparison Of Mean Hr Between Controls And Cases

Control/ Cases	N	Mean	Std. Deviation	P value
Mean H-R Control (bpm)	30	74.5110	13.54621	0.02*
Cases	30	83.3250	14.72590	

Table:3: The mean ± SD values of mean H-R in beats per minute in the control group was 74.51 ±13.55 and in the study group was it 83.33 ±14.73 beats per min. The mean value of the heart rate was increased in the study group and the difference was found to be statistically significant with a p-value of 0.02p value is 0.02.* Statistically significant

Table – 4: Comparison Of Sdnn Between Controls And Cases

	Control/ Cases	N	Mean	Std. Deviation	P value
SDNN	Control	30	67.7430	32.25802	0.17
	Cases	30	58.4283	17.28342	

Table:4 The means ±SD values of SDNN ms in the control groups were 67.74 ± 32.26 and in the study group 58.43± 17.28. The mean value of the SDNN was decreased in the study group and the difference was found to be statistically insignificant with a p-value of 0.17. the p-value is 0.17. Statistically insignificant

Table – 5: Comparison Of Rmssd Between Controls And Cases

RMSSD	Control/Cases	N	Mean	Std. Deviation	P value
	Control	30	25.7707	17.1639	0.01*
	Cases	30	15.9914	7.72673	

Table:5 The mean ± SD values of RMSSD (ms) in the control groups were 25.77± 17.16 and in the study group were 15.99 ± 7.73. There was a decrease in the mean value of RMSSD in the study group. The difference was found to be statistically significant with a p-value of 0.01 .p value is 0.01*** Statistically significant**

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Table – 7 Comparison Of Pnn50 Between Controls And Cases

pNN50	**Control/ Cases**			**Std.**	
		N	**Mean**		**P value**
				Deviation	
	Control	**30**	**3.6909**	**5.31307**	**0.01***
	Cases	**30**	**0.8527**	**1.84265**	

Table:7 The mean ± SD values of pNN50 (ms) in the control groups were 3.69 ± 5.31 and in the study group were 0.85 ± 1.84. There was a decrease in the mean value of pNN50 in the study group. The difference was found to be statistically significant with a p-value of 0.01. **the p-value is 0.01* Statistically significant**

Table:8 LF/HFRatio

LF/HF Ratio	Control/ Cases	N	Mean	Std. Deviation	P value
	Control	30	0.9730	0.68397	0.72
	Cases	30	1.0429	0.83125	

The mean ± SD values of the LF/HF ratio in the control groups was 0.97 ± 0.68 and in the study group was 1.04 ± 0 .83. The mean value of the LF/HF ratio in the study group was increased when compared to the control group and the difference was found to be statistically insignificant with the p-value of 0.72.

Discussion

Variations in heart rate are a probable indicator of forthcoming cardiac diseases. It is the analysis of the heart rate against the time axis. HRV analysis is a non-invasive tool for the assessment of autonomic function linked with the autonomic nervous system. HRV predicts sympathetic, parasympathetic, and autonomic balance and also assesses the risk factors such as sudden cardiac death.LF – low-frequency range is associated with sympathetic activity and high-frequency range is associated with the parasympathetic activity. [11] The difference in frequency helps us to differentiate the sympathetic and parasympathetic actions. By analyzing HRV parameters, autonomic imbalance in diabetes can be prevented at an early stage which could be beneficial to prevent the complication of diabetes mellitus. Frequency domain measures of HRV is a sensitive, quantitative method to assess the sympathetic and parasympathetic system. There is the possibility of tachycardia and a decrease in beat-to-beat changes if there is a greater involvement of sympathetic activity in the individual. If the parasympathetic influence is more in an individual then there are greater chances of bradycardia and consequently, there is increased beat-to-beat variation. Reduced variation in a heartbeat is an early predictor of cardiovascular disease and this can even increase the mortality rate in them.[12] The mean RR interval and HR denote the balance of sympathetic and parasympathetic activity of ANS. The reduced heart rate and the prolonged RR interval denote parasympathetic overactivity and increased heart rate and decreased RR interval denote sympathetic dominance. [13] In our study, diabetics who were diabetics showed a decrease in mean RR and an increase in HR and the difference was statistically significant compared to the control group.RR variability is shown in diabetic patients and they are prone to cardiac arrhythmias and death. Heart rate is calculated from the RR interval of ECG. Other parameters like SDNN, the standard deviation

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of NN interval, RMSSD the root mean square of the successive difference of interval, and PNN50, the number of successive differences of the interval which differs by more than 50 milliseconds expressed as % of the total number of ECG cycles are analyzed. [14] In our study, the SDNN of our study group was decreased when compared to the control group. Our study showed a decreased value of SDNN in diabetic subjects which were similar to this study.RMSSD is a time domain parameter of HRV. European heart journal guidelines state RMSSD method is a preferred, better statistical method. [15] Joel Mukesh Kaja Arumugam et al also demonstrated a decrease in RMSSD in the study group compared to the control group without diabetic mellitus.pNN 50 is the NN50 count divided by the total number of all `N' intervals in our studies pNN50 was found to be decreased in the study group and it showed an increase in sympathetic and parasympathetic activity indicating cardiac electrical instability. Frequency domain analysis is considered a precise tool for assessing autonomic function.[16] Frequency domain parameters like LF, HF, and LF/HF ratio have been analyzed. There is a general belief that LF denotes the sympathetic component but there is a difference of opinion regarding this as some others believe that it denotes both the sympathetic as well as parasympathetic components. LF/HF ratio denotes the sympathetic balance. A decrease in the ratio indicates increased parasympathetic tone. [17] In our study LF nu was slightly increased in the study group and the difference was found to be statistically significant. LF is a quantitative marker of sympathetic modulation and it is an important parameter of HRV depicting the sympathetic activity. [18] Sympathetic activity dominates due to the impairment of vagal activity so that the sympathovagal homeostatic mechanism is maintained. In our study, HF nu was marginally decreased in the study group of offspring of diabetics with diabetes compared to the control group without diabetes which was statistically insignificant.HF component determines parasympathetic activity. This finding was consistent with the study done by Larsen ML et al who did a research study on HRV with 30 diabetic patients denoting suppression of parasympathetic activity in diabetics. [19] This study was similar to our study. Axonal degeneration of the vagal nerve fibers would be the probability of developing neuropathy which is a complication of DM.LF/HF ratio is a marker of sympathovagal balance. LF/HF ratio was increased in the study group compared to the control and the difference was found to be statistically insignificant. Our observation was similar to the study done by H. Lateefat B et al in which parasympathetic activity was diminished in diabetics with the HF power being reduced, thereby LF/HF ratio was increased denoting sympathetic dominance.[20]

Conclusion

HRV is a simple, non-invasive assessment tool for predicting autonomic dysfunction in diabetic patients. Even in diabetic patients who did not have diabetes, autonomic modulations if any, can be picked up by HRV analysis. Hence we did a study comparing the time and frequency domain parameters in diabetics with diabetes and without diabetes. Time domain measures of HRV in diabetics with diabetes showed a reduced mean RR and increased HR which is applicable to represent significant sympathetic dominance and a decreased RMSSD and pNN50 imply a significant reduction in parasympathetic activity. The marginally increased LF nu indicates increased sympathetic activity whereas marginally decreased HF nu relates to a decrease in parasympathetic activity. The increased LF/HF ratio is due to reduced parasympathetic activity or impaired sympathetic activity. These are the frequency domain measures measured in HRV related to our study.

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