Original Research Paper

Physiology

# "A STUDY OF HEART RATE VARIABILITY IN PATIENTS WITH TYPE 2 DIABETES MELLITUS"

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**ABSTRACT** **Introduction:** Heart rate variability is the gold standard parameter for cardiac autonomic dysfunction. The aim of this study is to evaluate the heart rate variability in type 2 diabetes mellitus patient and the damage of autonomic nervous system, Low heart rate variability is a marker for the cardiac autonomic dysfunction which reflects the sympathetic and parasympathetic part of the autonomic nervous system on the sinus node, hence there is increased risk of ventricular arrhythmia and sudden cardiac arrest. **Method:** 100 cases of Type 2 Diabetes Mellitus patient of age 40-65 year of age of both sex match with controls in the time domain analysis we measure the RR interval (NN), mean RR interval (mean heart rate), standard deviation in RR interval (SDNN), root mean square of successive differences (RMSSD) and percentage of Beats with a consecutive RR interval difference (PNN50), in frequency domain LF and HF ratio measured. **Result And Statistical Analysis:** Statistically no significant difference between Type 2 Diabetes Mellitus patient and without Type 2 Diabetes Mellitus patient (control) for the age and sex in the time domain analysis however reduced value of all the parameters was obtained. For frequency domain low frequency (LF) and high frequency (HF) ratio which was significantly lower in Type 2 Diabetes Mellitus patient in the age group 40-50 and 51-61 but not significant more than 61 years age group. **Conclusions:** We were able to find out with this study that Type 2 Diabetes Mellitus patient associated with overall decrease heart rate variability due to cardiac autonomic nerve fibre damage and dysfunction leading to decrease activity in both sympathetic and parasympathetic which can be explained by the deleterious effect of altered glucose metabolism on heart rate variability. Since heart rate variability is gold standard, non-invasive, reliable measurement so it gives the benefit to evaluation in assessing and monitoring the severity of Type 2 Diabetes Mellitus patient

**KEYWORDS :** Heart rate variability, diabetes mellitus, autonomic nervous system.

## INTRODUCTION:

The study of heart rate variability gives analysis of variability in the heart rate in successive RR interval (series of time interval between Heart beats) in electrocardiogram which is measured over a period of 6-minute continuous electrocardiogram.[1] Diabetes Mellitus is characterised by hyperglycaemia resulting from the defect in insulin secretion, action or both which leads to damage, dysfunction and failure of various nerve fibre of vital organs along with cardiac autonomic nervous system.[2,3]

In previously conducted studies on heart rate variability in type 2 diabetes mellitus patient reduced value of heart rate variability in time domain and frequency domain analysis was obtained.

Sung Il Im et al. in year 2023 concluded that inadequate control of glucose levels is independently correlated with decreased HRV in individuals with DM which was further supported by the continuous independent correlation observed between real-time hyperglycaemia measurements and reduced HRV. These findings strongly imply that elevated blood sugar levels contribute to cardiac autonomic dysfunction.[4]

Mostafa Bahremand et al. in year 2019 deduced that patients with poorly controlled blood glucose levels exhibited significantly lower HRV indices compared to those in a euglycemic state. This cardiovascular dysfunction persisted after two years of follow-up. Serum HbA1C levels showed a significant inverse correlation with HRV indices. The disturbance in cardiovascular autonomic nervous system function and its association with blood glucose control status suggest the need for further studies to explore interventions aimed at reducing related complications.[5]

H KUDAT et al. in year 2006 summarized that individual with diabetes exhibited reduced heart rate variability (HRV) parameters compared to healthy controls, with those experiencing microvascular complications demonstrating the lowest HRV values among diabetic patients. It is recommended to intensively monitor patients with microvascular complications and consider insulin therapy to impede the advancement of cardiac autonomic dysfunction.[6]

EMILY B. SCHROEDER et al in year 2005 found that Cardiac autonomic dysfunction seems to manifest during the initial phases of metabolic impairment in diabetes, and a gradual decline in autonomic cardiac function was noted over a span of 9 years in diabetic individuals. However, the extent to which metabolic impairments in insulin and glucose metabolism during the prediabetic stage contribute to the decline in cardiac autonomic function remains uncertain.[7]

## MATERIAL AND METHOD:

In this observational analytical study having crossectional design, which was carried out for around 2 years period, patients (40-65 years both sex) who attended opd /ipd medicine department and NCD clinic at murshidabad medical college and hospital was taken into consideration.

The present study comprised individuals who were willing to participate in the research and who had history of diabetes mellitus lasting more than 5 years. Patient with type 2 diabetes mellitus were grouped as cases, while patient without type 2 diabetes mellitus were grouped as control.

The confirmed cases and control were examined in department of physiology for heart rate variability. At first, we used 12 channel ECG (6-minute electrocardiogram tracing technique). The ECG was store for 6 minutes. Then this ecg was exported into corresponding HRV software for further processing and analysis. Heart rate variability will then compute in the time and frequency domain ranges. This will automatically provide values for different type of parameters (SDNN, RMSSD, PNN50, etc) in time domain analysis and LF/HF ratio in frequency domain analysis. The values of each parameter of each domain analysis were tabulated categorised and analysed using computational and statistical software. The model number electrocardiogram machine used was RMS (RECORDERS AND MEDICARE

SYSTEMS PVT.LTD.) Vesta121 I and software used was 3.0.3 version.

All the data were analysed using SPSS package (Stata, version 26.0 SPSS INC, Chicago, IL, USA) for windows. The data were presented as descriptive statistics for continuous variables and percentage for categorical variables and was subjected Chi-square test, t test & Anova test. Other values were represented in number, proportions (%) and mean ± SD. P-values less than 0.05 were regarded as statistically significant.

Table 1: Age distribution of subjects

| Age | Case Group | | Control Group | | P value |
|---|---|---|---|---|---|
| | Num. | % | Num. | % | |
| 40-50 | 51 | 51% | 50 | 50% | |
| 51-61 | 27 | 27% | 19 | 19% | |
| >61 | 22 | 22% | 31 | 31% | <0.001 |
| Total | 100 | 100% | 100 | 100% | |
| Mean±SD | 52.19±7.85 | | 52.74±8.68 | | |
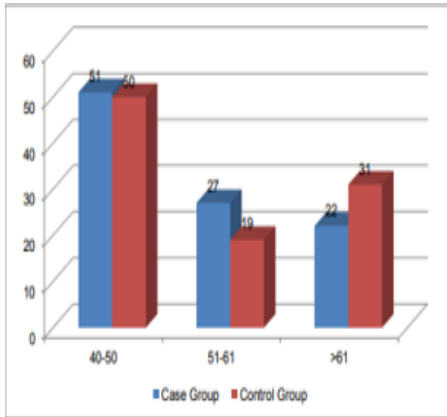


Table 2: Sex distribution of subjects

| Sex | Case Group | | Control Group | | P value |
|---|---|---|---|---|---|
| | Num. | % | Num. | % | |
| Male | 68 | 68% | 58 | 58% | |
| Female | 32 | 32% | 42 | 42% | <0.001 |
| Total | 100 | 100% | 100 | 100% | |
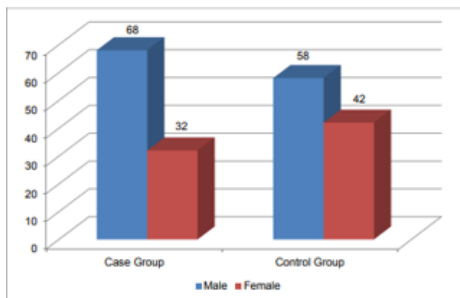


Table 3: SDNN (ms)

| SDNN (ms) | Case Group | Control Group | P value |
|---|---|---|---|
| | Mean±SD | Mean±SD | |
| 40-50 | 130.78±109.23 | 136.68±120.24 | 0.245 |
| 51-61 | 91.15±72.10 | 110.83±119.15 | 0.532 |
| >61 | 139.32±95.00 | 142.81±102.46 | 0.908 |
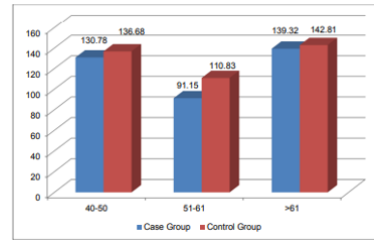


Table 4: RMSDD (ms)

| RMSDD (ms) | Case Group | Control Group | P value |
|---|---|---|---|
| | Mean±SD | Mean±SD | |
| 40-50 | 194.37±171.22 | 201.57±183.41 | 0.125 |
| 51-61 | 129.65±113.11 | 152.85±173.61 | 0.629 |
| >61 | 204.18±159.78 | 207.92±171.64 | 0.936 |
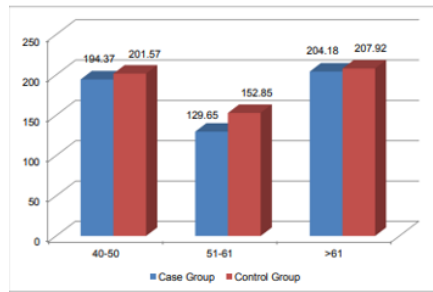


Table 5: PNN50 (%)

| PNN50 (%) | Case Group | Control Group | P value |
|---|---|---|---|
| | Mean±SD | Mean±SD | |
| 40-50 | 33.20±26.68 | 40.77±27.46 | 0.121 |
| 51-61 | 28.30±25.73 | 31.22±22.74 | 0.565 |
| >61 | 33.42±26.43 | 36.31±25.90 | 0.719 |
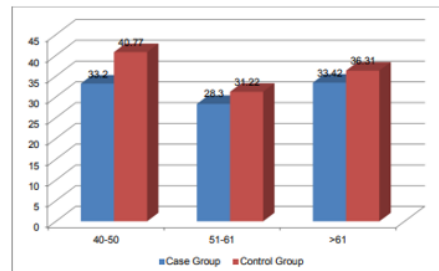


Table 6: LF/HF RATIO

| LF/HF RATIO | Case Group | Control Group | P value |
|---|---|---|---|
| | Mean±SD | Mean±SD | |
| 40-50 | 0.44±0.44 | 0.85±0.87 | 0.003 |
| 51-61 | 0.73±0.62 | 1.58±0.19 | 0.016 |
| >61 | 0.80±0.47 | 0.98±0.62 | 0.304 |
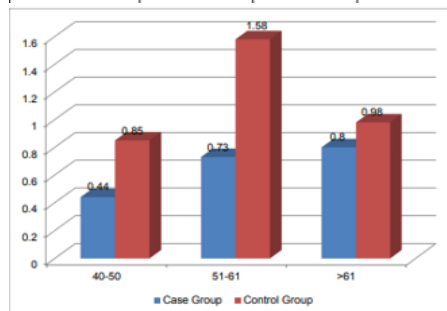
## RESULTS:

Statistically no significant difference between Type 2 Diabetes Mellitus patient and without Type 2 Diabetes Mellitus patient (control) for the age and sex in the time domain analysis however reduced value of all the parameters was obtained. For frequency domain low frequency (LF) and high frequency (HF) ratio which was significantly lower in Type 2 Diabetes Mellitus patient in the age group 40-50 and 51-61 but not significant more than 61 years age group. The p value of respective parameter of time domain analysis was more than 0.05 while in frequency domain analysis less than 0.05 in 40-50 and 51-61 years and more than 0.05 in more than 61 years of age group. Since the heart rate variability obtained is reduced in time domain analysis (SDNN, RMSSD, PNN50) and significant reduction in frequency domain analysis (LF/HF ratio) indicate the autonomic nervous dysfunction and increase risk of cardiac arrythmia and sudden cardiac arrest.

## DISCUSSION:

Variations in heart rate can serve as potential indicators of impending cardiac diseases, as they reflect the heart's activity over time. Heart Rate Variability (HRV) analysis offers a non-invasive method for assessing autonomic function associated with the autonomic nervous system. HRV provides insight into sympathetic, parasympathetic, and overall autonomic balance, helping to identify risk factors such as sudden cardiac death[8].

### Discussion of time and frequency domain analysis as follows:

SDNN In our study of time domain analysis, SDNN of our case group was decreased as compared to the control group but the decrease was not significant in any of the age group since p value are 0.245, 0.532 and 0.908 in respective age groups 40-50 years, 51-61 years, and more than 61 yrs.

RMSSD- In the case group, in our study in the time domain analysis RMSSD was found to be reduced compared to the control group but the reduction in the case group was not significant compared to the control group as the p value obtained are 0.125, 0.629 and 0.936 of respective age group 40-50 yrs,51-61 years and more than 61 years respectively PNN50- In our research, pNN50 was observed to decrease in the case group, suggesting an increase in both sympathetic and parasympathetic activity, indicating cardiac electrical instability. Our findings are showing that pnn50 of the case group was reduced but there is no significant reduction of pnn50 since p value of obtained are 0.121, 0.565 and 0.719 in the respective age group of 40-50 years,51-61 years and more than 61 years respectively.

**LF/ HF RATIO:** In our study frequency domain analysis LF/HF ratio was significantly reduced in case group as compared to the control group as the p value obtained are 0.003 and 0.016 of respective age group 40 to 50 years and 51 to 61 years respectively but there is no significant reduction in the case group of more than 61 years of age because p value obtained is 0.304. Our research findings align with many previously conducted studies.

## CONCLUSION:

Worldwide, diabetes mellitus ranks as the fifth leading cause of death. The swift escalation of type 2 diabetes mellitus underscores the presence of a significant global epidemic [9]. 75 HRV serves as a straightforward, non-invasive gold standard method for predicting autonomic dysfunction in diabetic patients. Even in offspring of diabetic patients without diabetes themselves, HRV analysis can detect any autonomic modulations present. Therefore, we conducted a study comparing the time and frequency domain parameters of heart rate variability in type 2 diabetes mellitus patient (case) compared with without type 2 diabetes mellitus patient(control). Time domain measures of HRV in diabetics revealed a decreased mean RR and increased HR, indicative of notable sympathetic dominance, while decreased SDNN RMSSD and pNN50 suggested a significant reduction in parasympathetic activity. In our study of time domain analysis SDNN, RMSSD and PNN50 was reduced in case group but there was no significant reduction compared to the control group. In frequency domain the increased LF/HF ratio is due to reduced parasympathetic activity or impaired sympathetic activity. In our study of frequency domain analysis significant reduction was obtained in the 40-50 years and 51-61 years age group which shows that parasympathetic dominance of autonomic nervous system but no significant reduction was obtained in more than 61 years of age.

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