Effect Of Type II Diabetes On Heart Rate Variability: Gender Relate Differences

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Abstract

The purpose of this study was to investigate the Type II diabetes male and female heart rate variability. Heart rate variability (HRV) is a reliable reflection of the many physiological factors modulating the normal rhythm of the heart. In fact, they provide a powerful means of observing the interplay between the sympathetic and parasympathetic nervous systems. Hence, HR variation analysis (instantaneous HR against time axis) has become a popular noninvasive tool for assessing the activities of the autonomic nervous system. In this work following data sets were formed 1) 18 type-II Diabetes Mellitus (DM) female subjects and 18 type-II DM male subjects.2)18 type-II DM female subjects and 18 Normal Control (NC) female subjects. 3)16 type-II DM male subjects and 16 NC male subjects. ECG and HRV recordings and autonomic nervous system activities are quantified by means of frequency and time domain analysis. Time domain measure, Standard deviation of successive NN intervals (SDNN), NN intervals differing more than 50 msec. (NN50 count),Percentage value of NN50 count (pNN50 count), HRV triangular index indicates the p-value lies in between 0.06 to 1.0 and no significant difference between two group parameters with the same pathology, Diabetes. Also no significant difference found in sympatho vagal balance, LF/HF with p-value >0.05

Keywords: Heart rate variability; Time domain and Frequency domain analysis; Diabetes Mellitus

1. Introduction

The ultimate goal of public health and clinical intervention is the prevention of diabetes and its complications like Diabetic Cardiac Autonomic Neuropathy. In addition to prevention, however, is the need to increase the use of currently available tools in the management of diabetes, in part through control of risk factors to prevent or mitigate the complications of the disease and in part through better treatment of these complications. It is well known that all people with diabetes have an increased risk of infections. This risk is further increased as a development of cardiovascular disease. The body's immune system consists of specialized cells that identify and destroy invading organisms. But when the blood flow that carries these cells to their destination is decreases, the ability of the cells to function normally is also decreases, leading to serious complications like cardiovascular disease. Therefore, we focused our research on CVD and diabetes. We investigated cardiovascular autonomic neuropathy in diabetics and healthy controls by analysis of heart rate variability. HRV analysis would emerge as an important tool for assessment of DM and cardiovascular health. Its extensive use has been made in signal processing, right from the stage of noise reduction to feature extraction and disease interpretation

1.1. HRV Related to Specific Pathologies

The Autonomous Nervous System (ANS) have sympathetic and parasympathetic components. Sympathetic stimulation, occurring in response to stress, exercise and heart disease, causes an increase in HR by increasing the firing rate of pacemaker cells in the heart's sino-atrial node. Parasympathetic activity, primarily resulting from the function of internal organs, trauma, allergic reactions and the inhalation of irritants, decreases the firing rate of pacemaker cells and the HR, providing a regulatory balance in physiological autonomic function. The separate rhythmic contributions from sympathetic and parasympathetic autonomic activity modulate the heart rate (RR) intervals of the QRS complex in the electrocardiogram (ECG). A reduction in HRV has been reported in several pathological conditions. Therefore in this work three data sets were developed to comparatively study the effect of Type II Diabetes on gender difference.

1.2. Gender Differences, Diabetes Mellitus and Heart Rate Variability

It is proved that, the HRV depends on the age. The HRV was more in the physically active young and old women. It is proved that, the HRV depends on the age and sex also. The HRV was more in the physically active young and old women [1, 2]. It was proved by Emese et al. [3] that the alert new borns have lower HR variation in the boys than in the case of girls. The HR variation for healthy subjects from 20 to 70 years was studied by Bonnemeir et al. [4] and found that the HRV decreases with age and variation is more in the case of female than men. Previous studies have assessed gender and age-related differences in time and frequency domain indices [5] and some nonlinear component of HRV. There also seemed to be a significant difference between day and night hours when studying HRV indices using spectral and time domain methods [5, 6].The amount of HRV is influenced by physiologic and maturational factors. Maturation of the sympathetic and vagal divisions of the ANS results in an increase in HRV with gestational age [7] and during early postnatal life [7]. HRV decreases with age [8, 9]. This decline starts in childhood [10]. Infants have a high sympathetic activity that decreases quickly between ages 5 and 10 years [11]. The influence of provocation on HRV (i.e., standing and fixed breathing) is more pronounced at younger ages [10]. In adults, an attenuation of respiratory sinus arrhythmia with advancing age usually predominates [12, 13].

2. Subjects and Method

2.1. Study population

Three following data sets were formed for analysis of ECG records from Normal controls and Diabetes Mellitus subjects. To study the effect of age gender and period of diabetes on Diabetic mellitus and Normal control HRV. 18 type-II DM female subjects and 18 type-II DM male subjects.18 type-II DM female subjects and 18 NC female subjects.16 type-II DM male subjects and 16 NC male subjects. Age matched NC and Type II DM subjects were chosen for study, with period of diabetes more than 5 years.

2.2. Time Domain Analysis

From the original RR intervals, parameters calculated: Mean R-R interval, on entire HRV recording, Mean HR, SDNN- the standard deviation of the NN intervals, RMSSD- the root mean square successive difference of intervals, pNN50% - the number of successive difference of intervals which differ by more than 50 ms expressed as a percentage of the total number of ECG cycles analyzed. The statistical parameters SDNN, RMSSD, NN50 (%), and pNN50% [14] can be used as time domain parameters.

2.3. Frequency Domain Analysis

The power spectra are analyzed and the comparison between the obtained indexes can be used to evaluate the response of sympathetic and parasympathetic branches of the nervous system. The Welch Periodgram is a method by which a large time-sampled waveform can be frequency-transformed by partitioning the data into shorter segments, transforming each segment, then, averaging the results over all the segments to create a composite frequency-space waveform. The spectrum is then obtained by averaging the spectra of these segments. This method decreases the variance of the FFT spectrum. The generalized frequency bands for these short-term HRV recordings are the very low frequency (VLF, 0–0.04 Hz), low frequency (LF, 0.04–0.15 Hz), and high frequency (HF, 0.15–0.4 Hz). The frequency-domain measures extracted from the PSD estimate for each frequency band include powers of VLF, LF, and HF bands and, the LF/HF power ratio. To achieve the main objective of this work, the power obtained from VLF, LF, HF band of the PSD, the important fact here is that the energy contained in the LF band is related to sympathetic activity of the signal, and that of the HF band is related to parasympathetic activity. The power in these bands is calculated based on the area under the curve, and the ratio between them (LF/HF) indicates the sympathetic parasympathetic balance in the segment of signal. An experimental result of this algorithm is given below.

2.4. Significance Test

In medical applications statistical inference is more often taken by the significance test. This is done by generating a *p*-value from a test statistic. All the parameters evaluated from time and frequency analysis, for both diabetic and normal control is tested for *p*-value using Mann-Whitney test. The significance level is set at 0.05; any test resulting in a *p*-value under 0.05 would be significant.

3. Results

Table No. 3.1. Time Domain and Frequency Domain Analysis

Parameter	DM Female	DM Male	*p*-Value
Mean R-R	696.35±46.01	752.12±68.50	0.06
Mean HR	86.55±5.37	80.45±8.01	1.00
SDNN	32.28±41	18.93±6.30	0.06
NN50	6.37±14.15	1.25±1.16	0.95
pNN50	3.18±7.27	0.625±0.58	0.11
LF	1054.55±785.73	640.35±913	0.11
HF	299.75±338.26	129.12±176.31	0.08
LF/HF	4.71±2.14	4.39±1.57	0.95

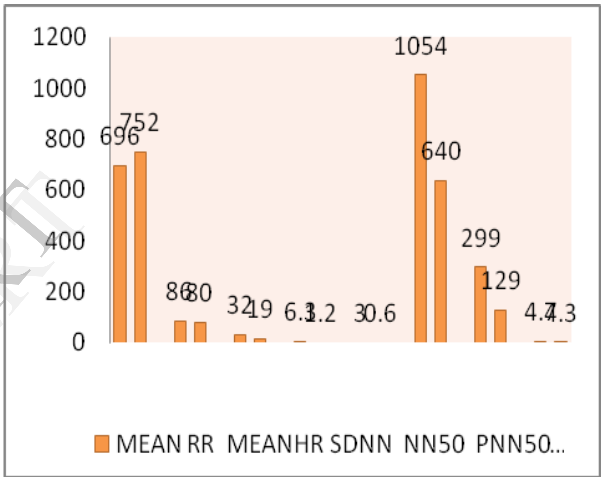

Figure 3.1 Graphical Representations of DM Female and DM male Indices Values

4. Discussion

As shown in Table 3.1 and figure 3.1, HF**,** 299.75 and 129.12. LH/HF, 4.71 and 4.39, for DM female and DM male respectively. The literature survey on HRV and gender difference, shown increased HRV in female than male but the parameters evaluated in this study indicates the *p*-value lies in between 0.06 to 1.0 and no significant difference between two groups parameters with the same pathology, Diabetes. Therefore Type II diabetes equally affects the genders, giving no specific variations in parameter

5. Conclusion

The importance of the assessment of HRV is evident but it is rarely used for baseline evaluation of individual cardiovascular risk in newly diagnosed patients with type II diabetes. As the age of the subject and period of diabetes increases, further diabetes makes no difference in gender and equally affects both male and female Autonomous Nervous System.

6. References

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