Comparison Of Pulse Rate Variability Among Type 2 Diabetics And Normal Individuals

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Abstract: Background: Cardiac autonomic dysfunction is one of the most common and serious complication of type 2 diabetes mellitus (DM). Pulse rate variability (PRV) is a simple and non-invasive indicator of cardiac autonomic functions. Aim: To assess and compare the cardiac autonomic functions using PRV in type2 diabetes patients and normal individuals. Material And Methods: The study included 38 type2 diabetic individuals and 37 healthy controls. Five minutes PRV was recorded in all the subjects. PRV indices, namely standard deviation of Normal to Normal (SDNN), root mean square of successive differences (RMSSD), total power (TP) and ratio of low to high frequency power of PRV, were calculated. Result: All parameters were summarised using median and inter quartile range. Mann-Whitney U test was used to compare median differences in all the parameters between the two groups. Statistically significant differences ($p<0.05$) were found in SDNN, RMSSD, TP, low frequency (LF) and high frequency (HF) parameters. Median SDNN of controls was 91.8ms with an inter quartile range of (58.03 – 236.55)ms and in diabetics median SDNN was 21.15ms with an inter quartile range of (16.07 – 26.92)ms. In controls median total power was 3904ms^2 with an inter quartile range of (3267 – 5370) ms^2. In cases median total power was 1025.50ms^2 with an inter quartile range of (492 – 1250) ms^2. Conclusion: Decrease in PRV indicates the presence of cardiac autonomic dysfunction in diabetics. Therefore PRV can be used as a simple, non-invasive method for assessing cardiac autonomic function in diabetic individuals. [Saha S Natl J Integr Res Med, 2022; 13(1): 64-68, Published on 26/01/2022]

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Introduction: Diabetes mellitus (DM) is a complex metabolic disorder characterised by hyperglycaemia resulting from defects in insulin secretion or insulin action or both[1]. Estimated number of people with diabetes worldwide in 2015 is 415 million and by 2040, 642 million people will have diabetes[2]. Approximately 5 million people died from diabetes in 2015 worldwide[2]. Current prevalence of diabetes in South East Asia is 78.3 million[2]. According to International Diabetes Federation, India is the second most prevalent country for diabetes after China with 69.2 million adults with diabetes.

Type 2 DM is the predominant form of diabetes which comprises almost 90% of the total cases worldwide. The metabolic deregulation associated with DM causes pathogenic changes in multiple organ system of the body. Overall life expectancy of type 2 diabetics is less than those without diabetes because of its complications. It has been associated with cardiovascular diseases, nephropathy, neuropathy, retinopathy and so on. In diabetes hyperglycaemia, increased free fatty acids and insulin resistance provoke molecular mechanisms that alter the function and structure of blood vessels[3]. Atherosclerosis, altered vascular flow, inflammation of blood vessels and altered glucose metabolism may lead to neuro degeneration.

Neuro degeneration can manifest in the form of peripheral or autonomic neuropathy. Epidemiological studies have suggested that almost 50-77% of the diabetic patients had evidence of cardiac autonomic neuropathy[4].

According to ADA screening for neuropathy should be done at the time of diagnosis of type 2 DM and if screening is negative, this should be repeated annually for both forms of neuropathy [5].

The autonomic nervous system plays an important role in the maintenance of normal homeostasis. Diabetic autonomic neuropathy can affect the functioning of multiple organ systems like cardiovascular, urogenital, gastrointestinal, thermoregulatory and sudomotor. Cardiac

autonomic neuropathy (CAN) is one of the most associated with higher risk of cardiovascular accidents and poor quality of life in diabetic individuals. Clinical symptoms of diabetic autonomic neuropathy occur long after the onset of neuropathy.

Photoplethysmography (PPG) is a simple, low-cost, non invasive, optical measurement technique which is used for the detection of blood volume changes in peripheral tissue[6]. Pulse Rate Variability (PRV) derived from PPG is used for assessing the autonomic activity. Pulse Rate Variability has been used for the analysis of ANS changes under different conditions, such as the presence of mental[7] or somatic diseases[8,9].

In this study cardiac autonomic functions were assessed using PRV in type2 diabetes patients.

Material & Methods: The study included 38 type2 diabetic individuals and 37 healthy age and sex matched controls after getting the informed clinically significant complications of DM. It is consent. The study was conducted from June 2015 to March 2016.

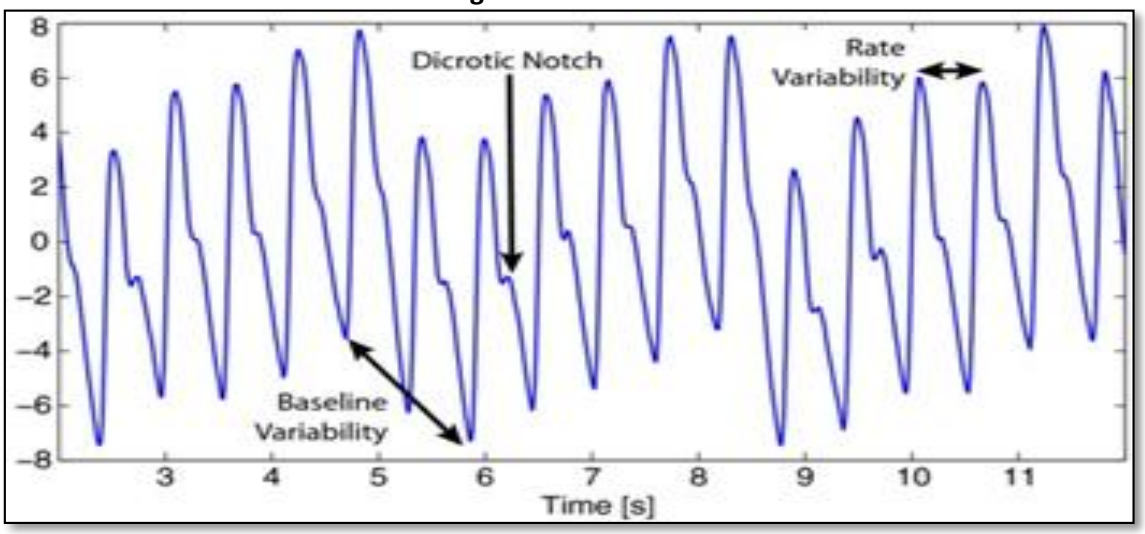
Individuals with history of autonomic neuropathy, past or present history of psychiatric and neurological disorder, history of ear and eye disease, chronic alcoholics and chronic smokers, patients with thyroid and renal disorder were excluded from the study. Ethical clearance was obtained from the authority.

Testing procedures and protocol were explained in details to the subjects. Written consent was obtained from the cases and controls.

The study subjects were evaluated by general history, clinical examination and blood HbA1c level.

The subjects were seated comfortably in a semi-darkened, acoustically shielded room. Five minutes PRV was recorded in all the subjects, Figure1.

Figure 1: PRV Waves



PRV indices, namely standard deviation of NN intervals (SDNN), root mean square of successive differences (RMSSD), total power (TP) and ratio of low to high frequency power of PRV, were calculated.

Statistical Analysis: All parameters were summarized using median and inter quartile range. Mann-Whitney U test was used to compare median differences in all the parameters between the two groups.

Results: The study was conducted on a group of 37 healthy individuals & 38 type2 diabetic patients. The study groups were similar on the basis of their age (P >0.05). The mean age of the controls were 26.83 ± 6.10 years and of diabetics were 30.73 ± 4.84 years.

The study groups had significantly different HbA1c levels reflecting their respective blood glucose level. The mean HbA1c level in diabetics was 7.4 ± 0.546 %.

Statistically significant differences ($p<0.05$) were found in SDNN, RMSSD, TP, low frequency (LF) and high frequency (HF) parameters. PRV parameters are summerised in Table 1.

Table 1: PRV Parameters

Parameter	Control		Diabetics		P value
	Median	IQR	Median	IQR	
SDNN(ms)	91.80	58.03 – 236.55	21.15	16.07 – 26.92	0.000
RMSSD(ms)	24.70	20.20 – 30.15	16.00	10.17 – 24.72	0.002
TP(ms^2)	3904	3267 – 5370	1025	492 – 1250	0.000
LF(ms^2)	815	4457.50 – 1485	219	133.25 - 328.25	0.000
HF(ms^2)	675	377.50-1315.50	318	93-281.50	0.000
LF/HF	1.2	0.72-1.50	1.5	0.68-2.11	0.299

Median SDNN of controls was 91.8ms with an inter quartile range of (58.03 – 236.55)ms and in diabetics median SDNN was 21.15ms with an inter quartile range of (16.07 – 26.92)ms. Median RMSSD of controls was 24.70ms with an inter quartile range of (20.20 – 30.15)ms and in diabetics median RMSSD was 16ms with an inter quartile range of (10.17 – 24.72)ms as shown in Figure 2. In controls median total power was 3904ms^2 with an inter quartile range of (3267 – 5370)ms^2. In cases median total power was 1025.50 ms^2 with an inter quartile range of (492 – 1250) ms2 as shown in Figure 3.

Figure2: Median SDNN AND RMSSD Of Controls (Group 1) And Diabetics (Group 2)

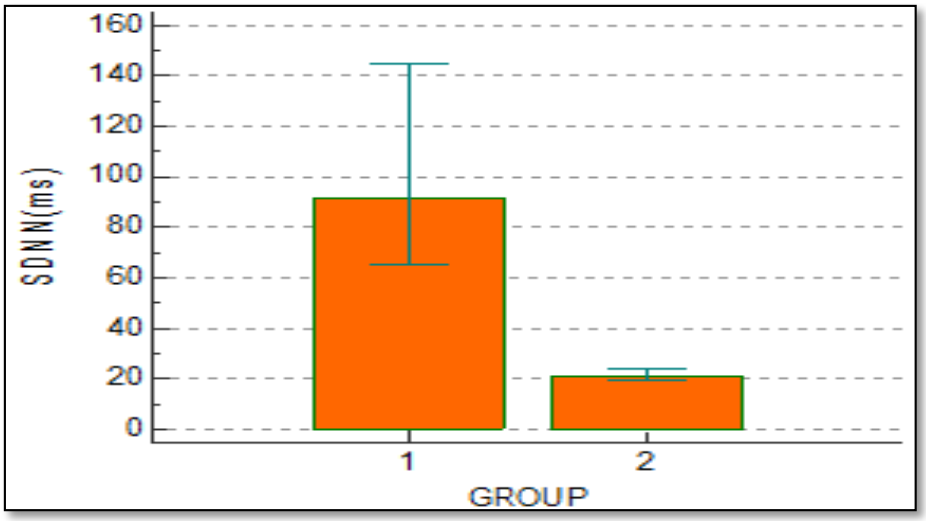
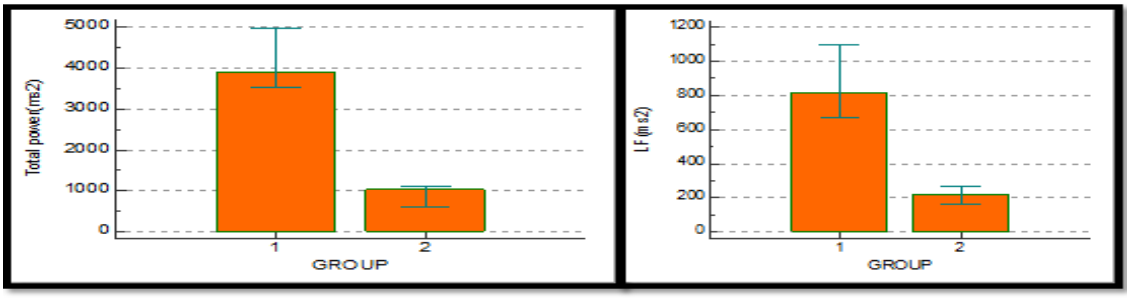
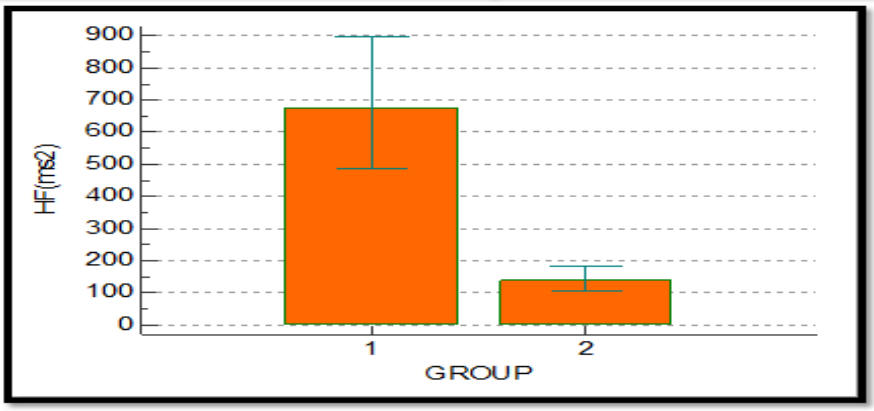


Figure 3: Median TP, LF And HF Values Of Controls (Group1) And Diabetics (Group 2)





Discussion: Diabetic neuropathy is a common complication of type 2 DM. It may manifest as peripheral neuropathy and autonomic neuropathy. Autonomic neuropathy is one of the less recognised complications of type 2 DM. In our study the PRV values were higher in healthy subjects compared with diabetics, reflecting a higher variability in the control group.

A reduction in SDNN and RMSSD was found in diabetic patients which was statistically significant ($p<0.05$). The total power, low frequency and high frequency components were also decreased in diabetic populations.

Ziegler D et al. showed that the SDNN, RMSSD, pNN50, TP, LF and HF values were higher in healthy subjects compared with diabetics[10].

Edwing DJ et al in their study showed an early onset of cardiac automic neuropathy[11]. Said G et al also concluded in their study that autonomic neuropathy was present in patients with type 2 DM[12].

In various study importance was directed to early warning signs of CAN such as reduced heart rate (HR) variability during deep breath, prolongation of QT interval, temporally followed by resting tachycardia, impaired exercise tolerance, and decreased baroreflex sensitivity with consequent abnormal blood pressure regulation, and orthostatic hypotension[13, 14].

A cross-sectional study on 387 diabetic adult patients showed that there was a tendency toward increased Cardiac autonomic neuropathy[15]. These findings correlate with the findings of the present study. Advantage of PRV is that the device is portable and the procedure is simple, noninvasive. It can be used as a screening test for Cardiac autonomic neuropathy in diabetics who are at risk of cardiovascular morbidity and mortality.

Conclusion: Decrease in PRV indicates the presence of cardiac autonomic dysfunction in diabetics. Therefore PRV can be used as a simple, non-invasive method for assessing cardiac autonomic function in diabetic individuals.

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