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Short-Term Measurement of the Pulse Rate Variability (PRV) in Overweight Patients with Type 2 Diabetes

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ABSTRACT

Background: The problem Pulse Rate Variability (PRV) in type 2 diabetes and increased body mass index has not been studied enough. Type 2 diabetes affects the peripheral vasculature leading to coronary, cerebral and peripheral vascular disease associated with oxidative stress and inflammatory processes. Similarly increase body weight also changes oxidative stress and inflammation that may adversely affect diabetes disease progression.

Methods: The Heart Rhythm Scanner Special Edition Version 1 (Biocom Technologies, USA) was used for PPG (Photoplethysmography) recording and PRY analysis.

Results: Our study found that short-term measurement of PRY shows some statistically significant differences using multifactorial analysis of type 2 diabetes with overweight and a healthy control group with normal weight. Short-term measurements ofPRV can be used as an alternative method for HRV. PPG-method can be used as preliminary screening tool for large populations with increased risk of heart problems. This is because the PPG method is simple to use and takes much less time.

Introduction: Up to now there are many scientific articles dealing witht he problem of Heart Rate Variability (HR V) in type 2 diabetes with increased body masss index (18.5<BMI<25). These studies showed that the HRV is decreased in type 2 diabetics with overweight compared with the healthy controls with normal weight. However, Pulse Rate Variability (PRV) in type 2 diabetes with increased BMI (BMI>25) has not been studied enough. (1).

That is why he is relevant and deserves to be investigated. It has been found that type 2 diabetics with overweight suffer more often from cardiovascular diseases and the mortality in them is greater.

There are several scientific studies conducted to establish that the PRY can be an alternative to the HRV (1, 2, 3, 4, 5, 6). These studies found that changes in the frequency and temporal parameters of HRV and PRY in type 2 diabetics are similar. Photoplethysmography (PPG) enables the non-invasive measurement of the peripheral pulse wave enabling assessment of cardiac time interval (10). PPG-method can be used as preliminary screening tool for large populations with increased risk of heart problems (7). This is because PPG method is simple to use and takes much less time. It does not require any electrodes. PPG is simple and only requires on small optical probe to be applied to the skin. In contrast to conventional electrocardiography (ECG) which requires several sticky electrodes to be carefully placed on the body, PPG measurements can help reduce possible 'white coat' effects on subjects. It has already been demonstrated that the pulse-to- pulse intervals (PPI) derived from PPG signals can be a surrogate for RR intervals (RR!) derived from ECG recordings. In this study pulse rate variability (PRV) was used to obtain HRV information (11).

METHOD

The study was conducted after approval by the Ethics committee of our hospital. It was conducted according to the international standards for the measurement of HRV (heart rate variability) (8). We investigated total 28 patients. Fourteen were type 2 diabetics with increased BMI (6 male, 8 female; age 40-64; BMI >25) and 14 healthy non-diabetic patients with normal weight (5 male, 9 female; age 40-59; BMI 18,5-25). All subjects were requested to avoid strenuous exercise, refrain from consuming hot drinks or those containing caffeine, or eatinga substantial meal for 1 h prior to the study.

All smokers were also asked not to smoke cigarettes for at least 1 h before their measurements, as acute smoking may be associated with hemodynamic changes in the cardiovascular system (13).

The measurement room temperature was set to 25±1 =C.

All subjects rested in supine position at least 10 min on a comfortable bed, and then the PPG signals were recorded in supine position during spontaneous breathing for 5 min.

Subjects were asked to remove any ear rings prior to there cording session. The left ear lobe was the measurement site for this study.

The Heart Rhythm Scanner Special Edition Version 1 (Biocom Technologies, USA was used for PPG recording and PRY analysis. The method of PRV Analysis allow for selective assessment of the function of both ANS branches- sympathetic and parasympathetic nervous systems (9). These systems are specifically responsible for engaging the body to cope with stress and restore the body once stress is over. They constantly work together trying to maintain regulatory balance (12,13). Chronic stress causes this balance to shift away from equilibrium and exhaust ANS reserves for adaption. PRV provides means to assess how both branches work and how balanced they are (14).

This device records the instantaneous pulse wave using a pulse wave sensor (PPG=photoplethysmography).

MEASUREMENT PROTOCOL

We performed a time and frequency domain PRV analysis in accordance with recognized standards (8). We measured the following HRV-parameters: The Spectral power indices- Total power, LF, HF, LF normalized, LF/HF ratio, VLF and the Time- domain parameters- SDNN and RMSSD.

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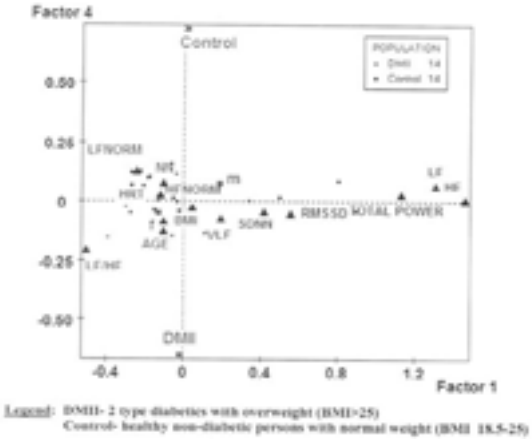
RESULTS

Data was recorded in Excel and a factorial analysis was performed. Wilcoxon test showed that BMI and age were significantly different between the two groups ($p<0.05$). The Multi factorial analysis showed that normalized low frequency power (LFnorm) discriminated between groups as it is variable with higher contribution in factor 4. LF represents the sympatic response. Otherwise HF can discriminate sex (female,male).



Legend: DMII- 2 type diabetics with overweight (BMI>25)
Control- healthy non-diabetic persons with normal weight (BMI 18.5-25)

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Legend: DMII-2 type diabetics with overweight (BMI>25) Controlhealthy non-diabetic persons with normal weight (BMI 18.5-25)

Time Domain Parameters

- NN: Mean NN (RR) Interval
- HRT: Mean Heart Rate
- SDNN: Mean of all the 5 minute standard deviation of NN (Normal RR)
- RMSSD: Square root of the mean squared difference of successive NN intervals (correlates to high frequency components)

Frequency Domain Parameters

- Very Low Frequency (VLF): From 0.0033 to 0.4 Hz
- Low Frequency (LF): From 0.04 to 0.15 Hz
- High Frequency(HF): From 0.15 to 0.4 Hz
- Total Power (TP): TP=VLF+LF+HF
- LF Normalized (LFnu): LFnu=LF/(LF+HF)
- HF Normalized (HFnu): Hfnu=HF/(LF+HF)
- LF/HF ratio

DISCUSSION

The PPG-method can be used to investigate the cardio- vascular system and the sympato-vagal balance in type diabetics with overnight. It showed that normalized low frequencies (LFnorm) discriminate between the investigate groups (diabetics and healthy controls with normal weight).

LF represents sympatic response. Therefore, in 2 type diabetics with an overnight the sympathetic function of the autonomous nervous system is impaired.

The Multifactorial analysis provides additional opportunities to study the pulse rate variability (PRV) in diabetes with overweight than the conventional statistical analysis.Most of type 2 diabetes persons (up to 90%) are obese and overweight.

There is a close link between obesity and type 2 diabetes on one hand and obesity and type 2 diabetes on one hand and obesity and type 2 diabetes and heart rate dysregulation on the other hand. That is why the PRV may become one of the popular nd most informative investigation dealing with the autonomous dysfunction in type 2 diabetics.

This method probably reflects the degree of metabolic illness in patients with type 2 diabetes. This is of particular importance because HBAIC(glicated hemoglobin) doesn't represent, what we call, the " Metabolic Health", Hence, This method can be viewed as a valued supplemental investigation, helping to assess the degree of metabolic problem in our patients.

Practical implementation of PRV.

As far as PRV is expected to reverse with weight loss and Metabolic(diabetes) control improving, its dynamic changes may be of a high importance in the treatment of type 2 diabetes and follow-up schedule.

More studies are needed to confirm our results and conclusions.

CONCLUSION

Our study found that short – term measurement of PRV shows some statistically significant differences using multifactorial analysis between type 2 diabetcs with overweight and healthy non-diabetic controls with normal weight.

Short-term measurement of PRV can be used as an alternative method of HRV. More studies are needed to confirm our results and conclusions.

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