Original Article

Comparative study of pre-prandial and post-prandial heart rate variability between obese and non-obese young women

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ABSTRACT

Background: In obesity, as excessive tissue accumulates, an altered metabolic profile occurs along with a variety of adaptations/alterations in the cardiac structure and functions even in the absence of comorbidities. **Aim and Objectives:** To study heart rate variability (HRV) and to compare in the pre-prandial and post-prandial state in obese and non-obese young healthy females. **Methodology:** 50 obese and 50 non-obese young healthy females aged between 21 and 25 years were selected based on body mass index. HRV was recorded in both pre- and post-prandial state by using computer based software device, digital finger pulse photoplethysmography (DFP) to identify separate frequency components, i.e., total power (TP), low-frequency (LF) power and high frequency (HF) power. **Results:** All the statistical methods were carried out through the SPSS for windows version 16.0. The independent samples T-test procedure was done to compare the means for the two groups. *P* value ≤ 0.05 was considered statistically significant. HRV analysis found significantly lower values of LF, HF in millisecond square (ms^2) and HF in the normalized unit (nu) and higher values of LF (nu) and LF/HF ratio among the obese group in both pre- and post-prandial state when compared to the non-obese group. **Conclusion:** Our data indicate that obese subjects have decreased parasympathetic activity as evidenced by decrease in TP (ms^2), LF (ms^2), HF (ms^2), and HF (nu), and increase in sympathetic activity as evidenced by increase in HR, LF (nu) and LF/HF ratio in both pre- and post-prandial state.

Key words: Digital finger pulse photoplethysmography, Heart rate variability, Obese young women, Pre-prandial and post-prandial

INTRODUCTION

Obesity is an emerging global health problem.[1-4] The nutritional problem in India is gradually shifting from undernourishment to obesity.[5] It is a disease, which has evolved with the advent of civilization, sedentary lifestyle, and high-calorie diet. Obesity is one of the causative factors for multiple co-morbid conditions leading to metabolic and cardiac disorders.[6] The incidence of overweight and obesity are increasing around the world especially in young adults and middle-aged people. There are increased chances of acquiring endocrinal diseases, genetic, and metabolic disorders.[7] Obesity is one of the risk factors attributed for the development of lipid abnormalities, insulin resistance, hypertension, etc. Growing number of evidence indicate an association of obesity and sudden cardiac deaths.[8-10] Imbalance in cardiac autonomic activity might be a pre-disposing factor for arrhythmogenesis and subsequently sudden cardiac deaths. Obesity is accompanied with varied combinations of abnormalities in the autonomic nervous system imbalance.[11]

Heart rate variability (HRV) is a specific and sensitive non-invasive tool to assess the cardiac autonomic activity. HRV is the degree of variation of the heart rate during the day under the balanced influence of sympathetic and parasympathetic component of the cardiac autonomic nervous system.

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It expresses the total amount of variation of both instantaneous heart rate and RR intervals. HRV also indicates the extent of neuronal damage to the autonomic nervous system.

This study is an effort to assess the effect of obesity on cardiac autonomic activity using HRV in young females.

METHODOLOGY

A comparative study was conducted. There were two study groups including 100 subjects. The subjects were 50 non-obese and 50 obese females in the age group between 21 and 25 years. Subjects were examined for their general physical health. Subject's clinical history and details were taken according to the standard proforma. Subjects were recruited for the study in VMKVMC Hospital Salem. Institutional ethical committee clearance was obtained. The subjects were recruited after a detailed history and thorough physical examination. Written informed consent was taken from all the subjects.

Subjects were classified into 2 groups based on body mass index (BMI) as follows:

Normal weight: BMI – 18.5-24.99 kg/m^2

Obese – BMI > 30 kg/m^2

BMI = Weight in kg/(height in meter)^2

Subjects were selected for the study on the 10^{th}-12^{th} day of their menstrual cycle.

Subjects with a history of Asthma, diabetes mellitus, hypertension, other cardiovascular diseases, endocrine disease or surgery, neuromuscular disorders, and subjects on chronic medication, were excluded from the study.

Subjects on any drugs affecting the functioning of the autonomic nervous system, adrenergic blockers, calcium channel blockers, anxiolytics, anesthetics, and narcotics were also excluded.

HRV was recorded in both pre- and post-prandial state using computer based software device Digital finger photo pulse plethysmography to identify separate frequency components.

Digital finger photo pulse plethysmography (Figure 1) transmitting infra-red light will be applied to the left index finger. The amount of light transmitted through the finger varies proportionally to changes in its blood volume. The signal from the digital finger photo pulse plethysmography was obtained over a 30-s period, to produce a single digital volume pulse waveform. Pulse wave for 5 min in pre- and post-prandial state and HRV components were recorded by computer based HRV software (Figure 2).

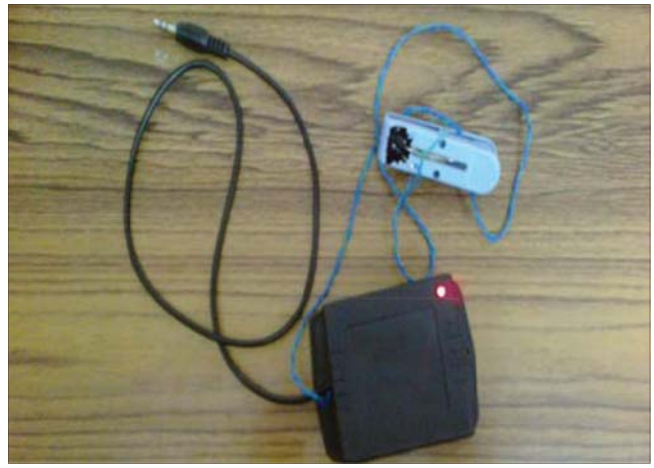

Figure 1: Digital finger pulse photoplethysmography

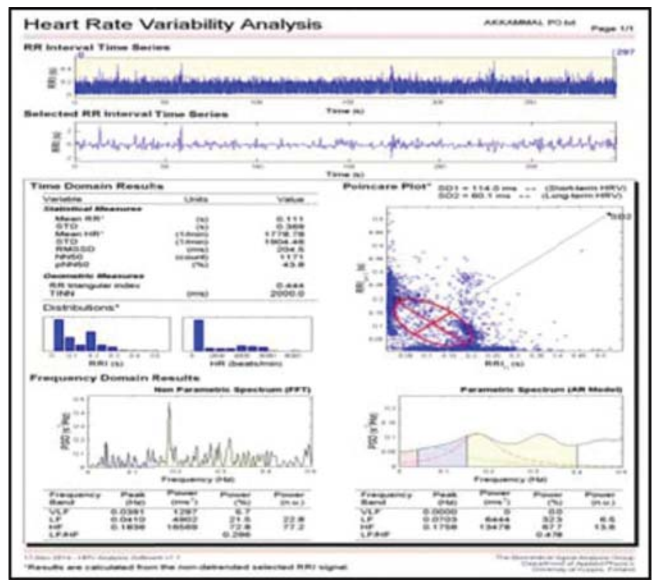

Figure 2: The pattern of heart rate variability graph which includes all frequency components and power values

The analysis of HRV[12]

Frequency domain analysis

The frequency Domain components of HRV were analyzed by using computer based HRV software. The power spectrum divided into bands of frequencies.

LF ms^2: Power in the low-frequency range.

HF ms^2: Power in the high-frequency range.

LF nu: Low-Frequency component, where nu means statistically normalized units. This mainly signifies sympathetic component.

HF nu: High-Frequency component, where nu means statistically normalized units. This signifies parasympathetic component.

LF/HF: Ratio of LF component to High-Frequency component, which signify the sympathovagal balance.

Statistical analysis

All data were expressed as the arithmetical mean, and standard deviation. Statistical analyses were performed using parametric methods. The upper 95% confidence limits in control subjects were used to establish abnormalities in the patients. This study was analyzed by Student unpaired *t* test. $P < 0.05$ was considered statistically significant.

RESULTS

Table 1 shows significantly lower values of LF, HF (ms^2), and HF (nu) and higher values of LF (nu) and LF/HF ratio among the obese group in both pre- and post-prandial state compared to the non-obese group.

DISCUSSION

Ingestion of food is a visceral stimulus that leads to metabolic and cardiovascular changes such as increased blood flow to the gastrointestinal tract (GIT) and a decreased skeletal muscle blood flow.[13] Peptides released in the GIT after food intake produces local vasodilatation. This leads to redistribution of blood supply to GIT. The enteric nervous system, that controls the pacemaker and motor activity of GIT, communicates with the central nervous system and interacts with the heart through the ANS.[14] The variations in heart rate are cyclic and non-cyclic. The cyclical variations are associated with various physiological functions such as respiration, baroreceptor reflex activity, thermoregulatory mechanisms, and changes in peripheral chemoreceptor activity and renin-angiotensin activity. These functions exhibit cyclical oscillations. Each of these oscillations occurs at a particular frequency, which gets reflected as a predominant peak in the frequency spectrum. Post-prandial regulation of central hemodynamics is highly dependent on the autonomic nervous system.[15] The probable reason for the insignificant alteration in cardiovascular autonomic tone after food intake in young healthy subjects is because of the redistribution of blood volume does not lead to any systemic changes in blood pressure. The sympathetic activity very quickly compensates for any effects of the parasympathetic activity after food intake.[16] In obesity, there was an alteration in cardio-autonomic activity due to hyperinsulinemia, baroreceptor down-regulation, and thermoregulatory mechanisms. The major findings of this study were that the obese group showed a significant reduction in LF, HF, HF nu, and significant increase in the values of LF nu and LF/HF in the post-prandial state when compared to the non-obese group. These findings indicate the presence of impaired parasympathetic activity and elevated level of sympathetic activity in the obese group. Thus, it showed a definite shift in the sympathovagal balance toward sympathetic component.

CONCLUSION

HRV is a specific and sensitive non-invasive tool to evaluate cardiac autonomic activity. It is a helpful indicator in the prevention of obesity-related diseases such as hypertension, coronary heart disease, and stroke-related events. Hence, our results support HRV as an effective modality in the early diagnosis of obesity-related diseases. Thus early interventional programs such as weight reduction, lifestyle changes, and physical exercises, which reduce the fat content of the individual, can be advised to reduce the chances of subsequent cardiac rhythm abnormalities.

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Table 1: Measurements of HRV components among obese and non-obese group of population

Parameters	Non-obese (*n*=50)			Obese (*n*=50)			*P* value (unpaired *t* test)
	Mean	SD	95% CI	Mean	SD	95% CI	
LF (ms^2) - pre-prandial	21173.4	1303.9	19559.3-23787.1	14837.7	3378.6	5473.7-24201.7	0.0141
Post-prandial	21174.3	1303.9	19559.9-23788.6	7633.7	974.8	4931.7-9335.8	0.0138
HF (ms^2) - pre-prandial	26866.2	6111.4	19927.2-33805.2	21174.3	6344.2	16746.2-28118.2	0.0231
Postprandial	11533.1	1450.7	9491.7-13533.9	9512.86	1015.8	8354.5-10986.1	0.0173
LF (nu) - pre-prandial	10.05	3.13	9.19-10.91	24.6	17.3	19.84-29.44	<0.0001
Postprandial	10.29	3.16	9.42-11.16	24.4	16.1	20-28.94	<0.0001
HF (nu)- pre-prandial	18.1	12.2	14.8-21.48	14.23	4.38	13.02-15.44	0.005
Post-prandial	17.9	12.1	14.56-21.28	13.86	4.37	12.65-15.07	0.005
LF/HF - pre-prandial	0.68	0.15	0.64-0.72	1.18	0.47	1.05-1.31	<0.0001
Post-prandial	0.94	0.25	0.87-1.01	1.47	1.43	1.08-1.86	<0.0001

LF: Low-frequency, HF: High-frequency, CI: Confidence interval, HRV: Heart rate variability, SD: Standard deviation

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