CARDIAC AUTONOMIC RESPONSE DURING A COLD PRESSOR TEST IN NORMAL AND OVERWEIGHT ADULTS

Geraldine Monteiro*, Vidya Chathoth, Kishan K

*Department of Physiology, Centre for Basic Sciences, Manipal University, Kasturba Medical College, Bejai, Mangalore-575 004
E-mail of Corresponding Author: drgeraldine.monteiro@gmail.com

Abstract
Objective: Aim of this study was to assess and compare the cardiac autonomic activity in normal and overweight adults.
Methods: The study included 50 subjects, of which 22 were boys and 28 girls in the age group of 17-20 years. The subjects were divided into groups 1 and 2 based on their BMI levels (Group 1: BMI< 25 and Group 2: BMI >25). ECG recording was done during normal breathing, deep breathing and cold pressor conditions. HRV was recorded and analyzed by the time-domain method, in accordance with the standards of measurement and interpretation defined by the Task Force of the European Society of Cardiology. Analysis of HRV in the time-domain was done using the software version 1.1 AIIMS, New Delhi. The data obtained was analyzed using student's t-test followed by Mann-Whitney U-test and $P < 0.05$ was considered significant.
Results: In the time-domain method, the mean value of SDANN in group 1 was higher than in group 2.
Conclusion: The study thus concluded that subjects with a normal BMI showed a better HRV response to cold pressor test, indicating a better parasympathetic activity as compared to obese subjects.
Keywords: Heart rate variability, Time domain, Body Mass Index

1. Introduction

Obesity is a medical condition in which excess body fat accumulates to the extent that it may have an adverse effect on health, leading to reduced life expectancy and/or increased health problems[1]. It is defined by Body Mass Index (BMI) and further evaluated in terms of fat distribution via the waist–hip ratio and total cardiovascular risk factors[2]. BMI is calculated by dividing the subject's mass (in kilograms) by the square of his or her height (in metres). The most commonly used definitions for BMI are given by the World Health Organization criteria[3].

Obesity is a modern pandemic, implicated in the pathogenesis of various diseases, particularly cardiovascular disease, diabetes mellitus type 2, obstructive sleep apnea, certain types of cancer, and osteoarthritis[1].

At an individual level, an excess of energy intake and an inadequacy of energy expenditure is thought to explain most cases of obesity[4]. Obesity is characterized by hemodynamic and metabolic alterations. Several studies in literature suggest that the autonomic nervous system of obese individuals is chronically altered[5]. Since the autonomic nervous system is involved in energy metabolism and regulation of the cardiovascular system, it is conceivable that one or more subgroups of obesity have an alteration in their autonomic activity that may account for several clinical consequences of obesity[6]. Obesity is a heterogeneous disease and the total fat accumulation and regional fat distribution may determine the development of autonomic pathophysiologies. Previous studies provide evidence that total body fat and central adiposity are associated with altered autonomic activity[7]. Autonomic imbalance associating increased sympathetic activity and reduced vagal tone has been strongly implicated in the pathophysiology of cardiac arrhythmias and sudden cardiac death[8].

Among the different available non-invasive techniques for assessing the autonomic status, heart rate variability (HRV) has emerged as a simple, non-invasive method to evaluate the sympathovagal balance at the sinoatrial level[9]. It expresses the total amount of variations of both instantaneous heart rate and RR intervals (intervals between QRS complexes of normal sinus depolarizations). Thus, HRV analyses the tonic baseline autonomic function. Time domain analysis measures the changes in heart rate over time or the intervals between successive normal cardiac cycles.

The cold pressor test which is considered to be a sympatho-excitatory manoeuvre is a simple, non-

invasive and validated test of sympathetic activation[10]. The heart rate and blood pressure responses could be used as indicators of global sympathetic activation, and thus, of cardiac status.

Although significant studies in relation to autonomic disturbances in obesity have been done in the Western population, there is a paucity of data in the Indian population. Hence, this work has been undertaken so that the cold pressor test could be employed as a mode of screening for cardiovascular risk in the obese, allowing for early intervention in order to prevent the associated morbidity and mortality.

2. Materials and Methods

This study is a cross-sectional study. The first year medical students (n=50) were the participants of the study. They were in the age group of 17-20 years. A detailed relevant clinical history was obtained from them. This was followed by a brief general physical examination, examination of vital signs and a complete systemic examination. Healthy subjects who could follow instructions and who would be doing their routine activities independently were included in the study. Those subjects with history of any respiratory, cardiovascular and neurological disorders, in addition to being incapable of performing a cold pressor test, were excluded from the study.

Height (Ht) was measured using a standard stadiometer with the subjects standing in erect posture. The readings were taken to the nearest 0.1 cm. Weight was measured using a calibrated weighing machine. The BMI was calculated using the standard formula: BMI=weight (kg)/height (m^2). Body Mass Index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters. Subjects were divided in two groups depending on the BMI given by WHO classification. Group 1 included those who had a BMI $\geq$25 kg/m^2 and group 2 (control group) included those with a BMI $\leq$25 kg/m^2.

Table 1: WHO Classification of BMI

BMI	Classification
<18.5	Underweight
18.5to24.9	Healthy
25to29.9	Overweight
30to39.9	Obese
>40	Morbid Obese

Subjects were included after counselling them about the nature and purpose of study. An informed consent was taken from the subjects for the same.

2.1 Measurement of heart rate variability: The following materials were included in the study: ECG appliances with jelly and electrodes, a digital data acquisition system**.**

A high quality ECG recording was taken under standardized conditions to minimize artefacts. The ECG signal was first analogally recorded and then digitally converted. Analysis of heart rate variability was done by the time-domain method.

The subjects were requested to come after their breakfast in a relaxed and quiet mood. Recording was done in the morning hours, between 8.30 to 9.30 a.m. in a cool room, with temperatures around 20 to 28 degree Celsius. The room was darkened and kept free of any acoustic disturbances. The procedure was explained to the subjects. They were instructed to relax and breathe spontaneously at their own rate.

After a resting period, the ECG of the subjects was recorded in the supine position during normal breathing for a 5 minute period. This was followed by a 2 minute break. The next ECG recording was then taken during deep breathing for about a minute. The subjects were asked to inspire for the first 5 seconds from the count of 1 to 5 and expire the next 5 seconds from the count of 5 to 1. This recording was taken for 6 such cycles, i.e. one minute.

2.2 Cold pressor test: The cold pressor test was performed in the supine position, and the subject's hand was immersed in cold water up to the wrist for 2 minute, followed by a 2 minute recovery period. Care was taken to ensure that the subject avoided any isometric contractions, breath holding or performance of Valsalva maneuver. HR and BP were continuously recorded online at rest and also during immersion. Data stored on the computer was analyzed after completion of the test.

2.3 Diagnostic criteria: Overweight was defined as BMI> 25 kg/m^2[3] based on the WHO criteria for classification of obesity[3].

2.4. Statistical Analysis: The present study was a cross-sectional study. The data were analyzed using the HRV software version 1.1 AIIMS, New Delhi. The data obtained was analyzed using ANOVA (Analysis of Variance), student's unpaired t-test followed by Mann-Whitney U-test and $P<0.05$ was considered significant.

3. Results

In the present study, depending on the BMI, 2 groups were formed, group 1 comprising of 25 subjects with BMI $\leq$25 and group 2 comprising of 25 subjects with BMI >25.

By the time domain method, the mean value of standard deviation of the average NN interval (SDANN) in group 1 was 27.78±13.29 and group 2 was 21.13±9.06 during CPT condition. Group 1 showed significantly higher HRV than group 2 (P<0.05).

The square root of the mean squared differences of successive NN intervals (RMSSD) of Group 1 was 44.04± 22.10 and that of Group 2 was 40.61±16.86 during CPT condition. Group 1 showed higher values, compared to Group 2, which was non-significant.

Table 2: Effect of BMI on HRV in Time Domain Method during Cold Pressor

	BMI < 25 (Group 1)	BMI >25 (Group 2)
SDANN	27.78±13.29*	21.13±9.06*

Test. n= 25 in each group

* P < 0.05:-Significant

4. Discussion

In the present study we assessed and compared the cardiac autonomic activities in normal and overweight adults using a cold pressor test. The main finding of this study was that HR and BP responses were reduced in obese subjects when compared to the non-obese subjects.

Obesity impairs autonomic control of heart rate and blood pressure[11]. Obese patients exhibit lower sympathetic responses on exposure to cold[11]. This study did show a significant reduction in the heart rate and blood pressure responses among the obese.

It is a well-known fact that the cold pressor test provokes a remarkable increase in sympathetic activity in humans mediated by central command and local metabolites, particularly adenosine[12]. Cold pressor test is often used to evaluate the sympathetic influence on circulation in humans. HR and BP responses in normal subjects are well characterized and different responses have been observed in a variety of clinical populations. In normal subjects HR is expected to increase 7-12 beats/min during the first 1-2 minutes of immersion and may stabilize or decrease with more prolonged immersion[13]. This change was exactly noted in the control group but there was a diminished response in the obese group.

This study thus concluded that subjects with a BMI<25 had a better heart rate variability response to a cold pressor test than those with a BMI >25, who demonstrated a poor heart rate variability. Thus it was inferred that a better parasympathetic response was noted in the non-obese rather than in the obese group.

Conclusions

The results of our study correlate with observations made by other researchers on the cold pressor test being a reliable screening tool in early diagnosis of autonomic cardiac dysfunction. The findings of our study suggested impaired autonomic function in the obese. The results of the present study are similar to other human studies with respect to cardiac autonomic dysfunction in the obese.

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