Comparative study of heart rate variability in normal and obese young adult males

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ARTICLE INFO

Keywords:
Body Mass Index
Heart Rate Variability

ABSTRACT

Our aim is to study the effect of obesity on Heart Rate Variability in young adult males. Our study focuses on using Heart Rate Variability to determine relation between obesity and cardiac autonomic disturbances in young males. Methods: Subjects were categorized as Controls (n=50) and Cases (n=50) based on BMI. ECG was recorded in a quiet room with the subject in supine position after 10 minutes of rest. Analog ECG signal was converted to digital by using National Instruments NI-DAQ 7.5 USBD 6008. HRV parameters like SDNN, E/I, LF nu, HFnu, LF/HF were calculated with the help of HRV software (version 1.1). Results: There was a significant (p<0.01) decrease in SDNN, E/I ratio, HF nu and a significant (p<0.01) increase in LF nu, LF/HF in cases when compared to controls. Conclusion: In obese group our study showed a significant reduction in parasympathetic activity and a significant increase in sympathetic activity. There was a shift in the sympathovagal balance towards sympathetic predominance among obese males in contrast to normal males.

1. Introduction

Nutritional problem in India is gradually shifting from undernourishment to obesity [1]. It is a condition, which has evolved with the advent of civilization, sedentary life style and high calorie diet [2]. Obesity is one of the causative factors for multiple co-morbid conditions leading to metabolic and cardiac disorders [3]. Growing number of evidences indicate association of obesity and sudden cardiac deaths [4,5]. Obesity is accompanied with varied combinations of abnormalities in the autonomic nervous system. One view is that obese people have a higher sympathetic tone that has been proved in some studies correlating with the catecholamine levels. But there is also evidence of reduced cardiac sympathetic tone in some studies which was partly explained on the duration of obesity [6]. Heart Rate Variability (HRV) is a specific and sensitive noninvasive tool to evaluate cardiac autonomic activity. HRV is the degree of variation of the heart rate under the balanced influence of sympathetic and parasympathetic components of the cardiac autonomic nervous system. HRV also indicates the extent of neuronal damage to autonomic nervous system [7]. This study is an effort to assess the effect of obesity on cardiac autonomic activity using Heart Rate Variability in young males as sudden cardiac death in later ages can be prevented if lifestyle modifications can be brought in earlier.

2. Methods and Materials

This study consists of 100 healthy male subjects in the age group of 20-24 years selected from the patient attendants coming to Sri Siddhartha Medical College Hospital, Tumkur. Anthropometric parameters like height and weight were recorded. Body Mass Index (BMI) was calculated by (8, 9). They were categorized as Cases (n=50) and Controls (n=50) based on the BMI. Controls whose BMI < 25kg/m2 and Cases with BMI > 30kg/m2. Subject’s clinical history and details were taken according to the standard proforma. Informed written consent was taken from all subjects in the study. Subjects with major illness like diabetes mellitus, hypertension, endocrinal disorders and on any drugs affecting the Autonomic Nervous System like adrenergic blockers, calcium channel blockers, others were also excluded.
2.1. Measurement of Heart Rate Variability parameters: [7]

Subject was explained in detail about the ongoing procedure and ECG was digitally recorded after 10 minutes resting using lead II. First, a 5 minutes ECG in supine position was recorded, with subject breathing normally and used to determine the SDNN LF, HF and LF/HF. Then, the person was periodically instructed to take alternating 5 seconds of deep inspiration and 5 seconds of deep expiration for a period of 2 minutes and simultaneous ECG was recorded. This data was used to measure the E/I ratio.

2.2. Instruments used
- ECG machine (BPL Cardiart 1087/MK-V) was used to acquire ECG signal.
- Analog to digital converter (National Instruments NI-DAQ 7.5 USBD 6008) was used as the hardware, to convert the analog signal to digital and processed it to the computer with the help of the NI-DAQ software.
- Heart Rate Variability software (version 1.1), was used in the computer, to detect the peak to peak intervals and further mathematical and analytical calculations in order to get the values of the parameters.

2.3. Statistical analysis
Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter group analysis). Student’s t test (two tailed; independent) has been used to test the homogeneity samples based on age (or continuous parameters).

3. Results
The mean age of the controls and cases were 21.24±1.47 and 21.82±1.52 respectively. Table-1 shows there was a statistically significant increase in BMI in cases when compared to controls. (p<0.001)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Controls</th>
<th>Cases</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>21.24±1.47</td>
<td>21.82±1.52</td>
<td>0.155</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>24.26±0.66</td>
<td>30.64±0.45</td>
<td>&lt;0.001***</td>
</tr>
</tbody>
</table>

Values: Mean ± SD
** Highly significant
** Very highly significant

Table-2 shows significantly reduced SDNN, E/I ratio, HF nu in cases when compared to controls suggesting the reduction in the parasympathetic activity. Significant increase in LF nu and LF/HF ratio shows elevated cardiac sympathetic activity in obese individuals. (p<0.01)

Our study results showed significant inverse relationship between BMI and HRV parameters like SDNN, E/I ratio and HF nu, but at the same it showed significant positive relation of BMI and LF nu, LF/HF.

<table>
<thead>
<tr>
<th>HRV</th>
<th>Controls</th>
<th>Cases</th>
<th>P value</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDNN (ms)</td>
<td>104.65±27.86</td>
<td>40.96±19.18</td>
<td>&lt;0.01**</td>
<td>2.64</td>
</tr>
<tr>
<td>(69.79-164.37)</td>
<td>(12.72-75.19)</td>
<td></td>
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</tr>
<tr>
<td>E/I ratio</td>
<td>1.73±0.15</td>
<td>1.32±0.14</td>
<td>&lt;0.01**</td>
<td>2.80</td>
</tr>
<tr>
<td>(1.39-1.97)</td>
<td>(1.11-1.56)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LF nu</td>
<td>39.06±7.34</td>
<td>71.81±9.72</td>
<td>&lt;0.01**</td>
<td>3.77</td>
</tr>
<tr>
<td>(24.63-54.80)</td>
<td>(45.88-87.95)</td>
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<td></td>
</tr>
<tr>
<td>HF nu</td>
<td>60.94±7.34</td>
<td>28.19±9.72</td>
<td>&lt;0.01**</td>
<td>3.77</td>
</tr>
<tr>
<td>(45.20-75.37)</td>
<td>(12.05-54.12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LF/HF</td>
<td>0.66±0.27</td>
<td>3.04±1.63</td>
<td>&lt;0.01**</td>
<td>2.02</td>
</tr>
<tr>
<td>(0.35-1.21)</td>
<td>(0.85-7.30)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values: Mean ± SD
** Highly significant
** Very highly significant

Figure. Comparison of time domain and frequency domain parameters between controls and cases

4. Discussion
The present study was designed to assess the effect of obesity on cardiac autonomic activity in healthy males 20-24 years. The major findings of this study indicate the presence of impaired parasympathetic activity and elevated level of sympathetic activity in obese group.

When parasympathetic activity is considered there is not much difference among the studies, as almost all of the studies show a significant reduction in the parasympathetic activity with increasing body weight, which were similar to our studies [13-16]. In contrast to our study some studies showed a significant reduction in the sympathetic activity. This variation among the studies was partially explained on the basis of the duration of obesity [17]. It has been said that duration of the obesity has a major role to play in determining the level of cardiac sympathetic activity [18].
Present study showed increase in sympathetic activity, but if the obesity is of a longer duration, then it is likely to lead to global reduction of the autonomic activity and hence a reduction in the sympathetic activity also [17].

This sympathovagal imbalance can explain the increased incidence of sudden cardiac deaths associated with obesity. Thus early interventional programs like weight reduction, life style changes and physical exercises, which reduce fat content of the individual, can be advised to reduce the chances of subsequent cardiac rhythm abnormalities.

5. Summary and Conclusions

The present study showed that among the subjects studied [males; 20-24 years] there was altered cardiac autonomic activity in obese individuals. Obese group showed a significant reduction of parasympathetic activity and a significant increase in sympathetic activity. There was a shift in the sympathovagal balance towards sympathetic predominance among obese males in contrast to normal males.

Limitations: - of the present study is that the duration of obesity was not considered in this study, which could have helped in establishing the relation of duration & effects of obesity on cardiac autonomic activity. There is scope for further studies like - study could be undertaken in various age groups and also in both genders for more clarity. Further a prospective study can be undertaken in the same subjects to know the effect of weight loss on the cardiac autonomic activity.

6. References