A STUDY OF AUTONOMIC FUNCTION TESTS IN OBESE PEOPLE

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ABSTRACT

**Background:** Obesity is one of the common significant health hazards and is associated with autonomic dysfunction. Aims and objectives: The present study was designed to assess the underlying autonomic neuropathy in obese subjects and to compare it with age-matched controls. **Material and Methods:** Thirty obese subjects in the age group of 21-40 years were recruited for the study. Six non-invasive autonomic function tests were performed out of which four were based mainly on parasympathetic control (Heart rate response to standing (30:15 ratio), The S:L (standing to lying) ratio, The Valsalva ratio, Heart rate response to deep breathing) and the other two were mainly sympathetic (Isometric Handgrip Exercise Test and Cold Pressor Test). **Statistical Analysis:** Results were analysed by ANOVA with SPSS version 17.0 using unpaired ‘t’ test. **Results:** Results showed that Heart rate response to standing (30:15 ratio), The S:L (standing to lying) ratio, The Valsalva ratio, Heart rate response to deep breathing, Isometric Handgrip Exercise Test and Cold Pressor Test were significantly lower (p <0.05) in obese subjects as compared to control subjects. **Conclusions:** Latent autonomic neuropathy may be present in otherwise healthy obese individuals. Early and regular screening of obese individuals is necessary to prevent any future complications.

**Keywords:** Obesity, Autonomic nervous system, Cold pressor test

INTRODUCTION

Obesity is a condition in which excess body fat accumulates to the extent that it may have an adverse effect on health¹. Obesity is a common and significant health hazard². At an individual level, an excess of energy intake and an inadequacy of energy expenditure is thought to explain most cases of obesity³,⁴. A complex interaction among different factors like endocrine, nervous, metabolic factors maintains constant energy storage⁵. Obesity is considered to be a risk factor for a variety of cardiovascular conditions like hypertension, ischemic heart disease and stroke³ and is characterized by hemodynamic and metabolic alterations⁶.

Autonomic nervous system is a centre for the coordination of different body system⁷. Since the ANS is involved in energy metabolism and in the regulation of the cardiovascular system⁸-¹⁰, it is
conceivable that one or more subgroups of persons with idiopathic obesity have an alteration in their autonomic nervous system that may account for several clinical consequences of obesity. Laitinen et al showed that total body fat and central body adiposity are associated with altered autonomic activity.

MATERIAL & METHODS

The present study was a cross-sectional study, conducted in Santosh Medical College; Ghaziabad, and the study was approved by the Institutional Ethics Committee. Thirty obese subjects with BMI >30 were selected for the study. The results were compared with thirty age-matched non-obese controls with BMI between 18.5-24.9. Informed consent was taken from all the subjects. Subjects with age above 40 years, h/o any chronic illness, on any medication, and smokers were excluded from the study.

Height was measured using a standard stadiometer with the subject standing in an erect posture. The readings were taken to the nearest 0.1 cm. Weight was recorded in kgs using a calibrated weighing machine (Avery) scale with a capacity of 120 kg and a sensitivity of 0.05 kg. The BMI was calculated as the weight in kilograms divided by the square of the height in meters [weight (kg)/height (m²)]

Subjects were divided into 2 groups as per WHO classification on BMI.

Group I-Control group with BMI 18.5-24.9kg/m²
Group II-Study group with BMI >30kg/m²

Table 1: WHO Classification of BMI

<table>
<thead>
<tr>
<th>BMI</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;18.5</td>
<td>Underweight</td>
</tr>
<tr>
<td>18.5-24.9</td>
<td>Healthy</td>
</tr>
<tr>
<td>25-29.9</td>
<td>Overweight</td>
</tr>
<tr>
<td>30-39.9</td>
<td>Obese</td>
</tr>
<tr>
<td>&gt;40</td>
<td>Morbid obese</td>
</tr>
</tbody>
</table>

The following autonomic function tests were performed:

For Assessing Parasympathetic Activity
1. Resting heart rate was calculated from ECG by using standard limb leads.
2. Heart rate response to standing (30:15 ratio) was calculated as the ratio between the R-R interval at beats 30 and 15 of the ECG recorded immediately upon standing.
3. The S:L (standing to lying) ratio was taken as the ratio of the longest R-R interval during the 5 beats before lying down to the shortest R-R interval during the 10 beats in the ECG after lying down.
4. The Valsalva ratio. Subjects were instructed to exhale into a mouthpiece connected to a mercury manometer and to maintain the expiratory pressure of 40 mmHg for 15 Sec. ECG was recorded during the manoeuvre and 45 sec after the manoeuvre. The ratio was calculated between the maximum R-R interval (after release of strain) and the minimum R-R interval (during strain).
5. Heart rate response to deep breathing: Heart rate was recorded first during normal breathing (at rest), and then during deep breathing (6/min). ECG 3rd & 6th respiration, minimum R-R intervals and corresponding heart rate were calculated.

For Assessing Sympathetic Activity:

Isometric Hand Grip Exercise Test: Before the exercise, subjects were allowed to rest for 10 minutes in a quiet room to reduce the anxiety. Resting blood pressure of all the subjects was measured by the auscultatory method with the help of a mercury sphygmomanometer (DIAMOND). First Kortkoff sound indicated systolic blood pressure (SBP) and fifth Kortkoff sound indicated diastolic blood pressure (DBP). Isometric handgrip exercise test was done in both the study group and control groups. After recording basal blood pressure, subjects were asked to perform isometric handgrip exercise. Subjects were told to hold the handgrip spring dynamometer in the right (or dominant hand) to have a full grip on it. Handles of the
dynamometer were compressed by the subject with maximum effort for few seconds. This whole procedure was repeated thrice with rest in between to prevent fatigue. Mean of the three readings was referred as maximal isometric tension (T max). Then, the subjects were asked to perform isometric handgrip exercise at 30% of T max for 2 minutes. During the test, blood pressure was recorded from the non-exercising arm. Blood pressure was again recorded 5 minutes after completion of the exercise.

**RESULTS**

Table 2: Anthropometric variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group I (Controls)</th>
<th>Group II (Obese)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>33.08±4.8</td>
<td>32.12±5.4</td>
</tr>
<tr>
<td>Height (mts)</td>
<td>1.62±0.42</td>
<td>1.51±0.56</td>
</tr>
<tr>
<td>Weight (kgs)</td>
<td>58.11±4.3</td>
<td>81.13±4.9</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>22.11±1.04</td>
<td>35.13±2.08</td>
</tr>
</tbody>
</table>

Table 3: Parasympathetic function tests in Group I and Group II

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group I (BMI 18.5-24.9)</th>
<th>Group II (BMI &gt;30)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate response to standing (30:15 ratio)</td>
<td>1.14± 0.11</td>
<td>1.06±0.02</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>S:L (standing to lying) ratio</td>
<td>1.2±0.03</td>
<td>1.11±0.02</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Valsalva ratio</td>
<td>1.65±0.28</td>
<td>1.45±0.11</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Heart rate response to deep breathing (HRDB)</td>
<td>23.46±4.31</td>
<td>16.46±2.11</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

* p<0.05 versus group I

Table 4: Statistical analysis of sympathetic function tests in Group I and Group II

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group I (BMI 18.5-24.9)</th>
<th>Group II (BMI &gt;30)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IHG SBP</td>
<td>12.2±1.2</td>
<td>8.3±1.3</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>IHG DBP</td>
<td>12.1±1.4</td>
<td>8.1±1.2</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>CPT SBP</td>
<td>12.2±1.6</td>
<td>8.2±1.4</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>CPT DBP</td>
<td>13.1±1.8</td>
<td>9.1±1.4</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

Data presented in Table 3 shows that there was significant decrease in the Heart rate response to standing (30:15 ratio), Valsalva ratio & Heart rate response to deep breathing (HRDB) in Group II individuals as compared to Group I(p<0.05). S:L ratio also decreased, and the decrease was statistically significant(p<0.05).

**Cold Pressor Test:** After recording basal blood pressure, subjects were asked to dip left arm in the cold water (temp at 2-4°C) for 2 minutes and blood pressure was recorded from the right arm. Blood pressure was once again recorded 5 minutes after hand was taken out from the cold water.

**Statistical Analysis:** Results were analysed by ANOVA with SPSS version 17.0 using an unpaired ‘t’ test.

Data presented in Table 4 shows that there was significant decrease in the systolic and diastolic blood pressure in obese subjects (group II) as compared to controls (group I) during the application of isometric handgrip exercise and cold pressor tests (p<0.05) and the decrease was statistically significant (p<0.05).
DISCUSSION

The results of the present study show that the
cvalsalva ratio, heart rate response to deep
breathing and heart rate response to standing
(30:15) in obese subjects were significantly
dlower as compared to the control group, it
indicates decrease in parasympathetic nerve
function and baroreflex sensitivity in obese
subjects. Baroreceptors resetting may occur in
obese individuals due to atherosclerosis that
hardens the carotid sinus walls. This decreases
compliance. Obese group is less responsive to
blood pressure changes to posture. Similar
results were shown by some other investigators\textsuperscript{21-23}.

There was less increase of blood pressure
response to cold pressor test in the obese people
in contrast to the control group. The afferent
fibres for this response are the pain fibres which
are stimulated by placing the hand in cold water
and the efferent fibres are the sympathetic fibres.
A lesser increase in the blood pressure after the
cold water immersion points towards
sympathetic insufficiency in obese subjects\textsuperscript{20}.
Obesity impairs autonomic control of heart rate
and blood pressure. Obese subjects exhibit lower
sympathetic response on exposure to cold. Our
study results were in accordance with reported
study of Monterio et al\textsuperscript{24}. There was also
decreased in blood pressure response to isometric
handgrip exercise test in the obese people in
contrast to the control group. It shows the
decreased activity of the sympathetic nervous
system\textsuperscript{25} or to a lower increase in peripheral
resistance to manoeuvres activating sympathetic
system\textsuperscript{26}. Baek et al\textsuperscript{27} stated that in normal
conditions sympathetic activity increases during
isometric handgrip exercise and cold pressor test.
This reduced sympathetic reactivity in
established obesity may be responsible for the
maintenance of obese state.

Valensi et al\textsuperscript{22} have demonstrated sympathetic
insufficiency in obese people. It was shown that
glucose induced inhibition of the lipid oxidation
rate in obese people is greater in the patients with
autonomic dysfunction which could be due to
decrease in parasympathetic activity.
Decrease in the sympathetic activity may result
in a disordered homeostatic mechanism thus
promoting excessive storage of energy as
suggested by Peterson\textsuperscript{9}.

It has been shown that increased sympathetic
activity induced by cold water stress causes
norepinephrine release and elevation of blood
pressure more in obese subjects. This greater
increase in blood pressure might be contributed
by more release of endothelins, prostaglandins
and angiotensin II\textsuperscript{29,30} in obese. Various
investigators have shown that parasympathetic
damage or decreased vagal tone may occur due
to hyperinsulinaemia or insulin resistance or
there may be decreased in baroreflex activity\textsuperscript{28}.

CONCLUSIONS

Obesity is associated with both sympathetic and
parasympathetic nervous system dysfunction
which may result in various cardiovascular
complications. So, if this dysfunction is
diagnosed early by doing various autonomic
function tests, it will be of great help in
identification of those which are prone to weight
gain and at risk of various cardiovascular
complications.

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Conflict of Interest: Nil

REFERENCES

1. Haslam DW, James WP. Obesity. Lancet


17. Levin AB. A simple test of cardiac function based upon the heart rate changes induced by the valsalva maneuver. Am J Cardiol 1966;1:90-99.


Garg et al.,


