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RESEARCH ARTICLE

A study to access impairment of autonomic nervous system in obesity

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ABSTRACT

Background: Obesity which is itself a significant health hazard is also associated with dysfunctioning of autonomic nervous system (ANS). **Aims and Objective:** This study was conducted to assess autonomic dysfunction in obese and compare it with age-matched controls. **Materials and Methods:** The study group consisted of 55 healthy obese people (median 35 ± 6.0 years of age) and the control group consisted of 55 healthy non-obese people (median 31 ± 5.2 years). 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 standing to lying ratio, Valsalva ratio, and the resting heart rate and the other two tests were based on sympathetic control (isometric handgrip exercise test systolic blood pressure (SBP) and cold-pressor test SBP, and diastolic BP). **Results:** Present study showed significantly lower values ($P \leq 0.005$) for the parasympathetic tests in the study group when compared to controls indicating impaired parasympathetic function. Similarly, the findings of sympathetic tests in study groups were significantly less ($P \leq 0.005$) as compared to the controls indicating impaired sympathetic function. **Conclusion:** Thus, in obesity activity of both sympathetic as well as parasympathetic divisions of ANS (autonomic nervous system) are affected, which may be the cause of various complications associated with obesity.

KEY WORDS: Autonomic Nervous System; Body Mass Index; Obesity; Valsalva Maneuver

INTRODUCTION

Obesity is a significant health problem in today's world which results from imbalance between energy intake and expenditure. It occurs due to the complex interaction of genetic, physiological, behavioral, and environmental factors.[1] Since autonomic nervous system (ANS) affects energy metabolism,[2,3] so it is deduced that idiopathic obesity is due to dysfunctioning of ANS and accounts for several clinical consequences of obesity.

Increase in adipose tissue causes a disturbance in the functioning of both sympathetic and parasympathetic nervous system.[4,5] Decreased amount of adipose tissue after weight reduction is associated with improved ANS function.[6,7] An individual with low resting sympathetic nerve activity may be at risk for body weight gain resulting from a lower metabolic rate because sympathetic nervous system determines the energy expenditure in our body.[8]

A number of studies performed prove an association between autonomic dysfunction and obesity. Van Vliet observed that there is the difference in resting heart rate between obese and non-obese dogs which was abolished after administration of an autonomic blocking drug.[9] This concludes that the development of obesity in dogs was accompanied by impaired autonomic regulation. In humans, muscle sympathetic nerve activity (MSNA) was elevated in obese volunteers as compared with non-obese volunteers, and MSNA was reduced after weight loss. Snitker and colleagues through their studies investigated the association between sympathetic nervous system activity and obesity and concluded that the sympathetic system has a key role in

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the development of obesity.[10] Central fat, and in particular, visceral fat, demonstrates the strongest inverse association with sympathetic nervous system functioning. Study by Laitinen *et al*. showed relationship between total body fat and central body adiposity and altered autonomic activity.[11]

MATERIALS AND METHODS

This study was carried out in the Department of Physiology, Hind Institute of Medical College, Safedabad, Barabanki, Uttar Pradesh, India, from January 2017 to July 2017.

The study was approved by the Ethics Committee. All the subjects were carefully instructed about the study protocol and informed consent to participate in the study was taken from each.

Inclusion Criteria

Fifty-five obese subjects with body mass index (BMI) >30 and 55 subjects with BMI between 18.5 and 24.9 were included in the study. BMI was calculated using the formula:

BMI=body weight (kg)/height (m^2).

Height was measured using a standard stadiometer with the subject standing in an erect posture. Weight was recorded in kg using a calibrated weighing machine (Avery) scale. Subjects were then divided into two groups as per the WHO classification on BMI.

Group I - Control group with BMI 18.5–24.9 kg/m^2.
Group II - Study group with BMI >30 kg/m^2.

Exclusion Criteria

Subjects suffering from cardiac problems, liver diseases, renal disease, neurological disease, immunodeficiency disease, HIV, or any other disease that affects ANS such as diabetes, hypertension, or patients taking any drug that affects autonomic activity were excluded.

Detailed clinical history was taken, including name, age, sex, occupation from all the subjects, and recorded. Special importance was paid to any clinical history or any symptoms suggestive of autonomic neuropathy.

For assessing sympathetic system activity, following tests were done:

1. Cold-pressor test (CPT) - Subject immersed his hand in cold water at temperature 4-6°C. Blood pressure (BP) measurement was made from other arm at pain threshold time. Maximum increase in systolic and diastolic pressures was recorded. Failure of systolic BP to rise by 16–20 mmHg and diastolic BP by 12–15 mmHg was indication of autonomic neuropathy.[12]
2. Isometric handgrip exercise test (IHG) - After recording basal BP, 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. During the test, BP was recorded from the non-exercising arm. Mean of the three readings were taken.

For assessing parasympathetic activity parameters used were as follows:

1. Resting heart rate – was calculated from electrocardiogram (ECG) using standard limb leads.
2. Valsalva ratio – calculated as ratio between maximal R-R interval after release of strain and maximal R-R interval during the strain.
3. 30:15 ratio – the 30:15 ratio was calculated by taking ratio of longest R-R interval at beat 30 and shortest R-R interval at beat 15 after standing.
4. Standing-lying ratio – being the ratio of longest R-R interval during five beats before lying down to shortest interval during 10 beats after lying down.

ECG was recorded by a simple compact electrocardiograph (BPL cardiart) unit. All the ECG recordings were carried out with lead II.

Statistical analysis was carried out using Student's *t*-test where the mean values of all parameters tested were compared between the obese and non-obese group.

RESULT

The results of the present study showed that the resting heart rate, Valsalva ratio, and standing to lying (S:L) ratio in obese subjects were significantly lower as compared to the control group which indicates decrease in parasympathetic nerve function. Similarly, findings of CPTs both systolic and diastolic and findings of IHG tests were significantly lower in the study group as compared to the control group which indicates decrease in sympathetic nerve function.

Table 1 summarizes WHO classification of BMI.

Table 2 summarizes anthropometric variables between control and study group.

Table 3 summarizes results of tests for parasympathetic functions between control and study group.

Table 4 summarizes results of tests for sympathetic functions between control and study group.

Table 1: WHO classification of BMI

BMI (kg/m^2)	Category
<18.5	Underweight
18.5–24.9	Healthy
25–29.9	Overweight
30–39.9	Obese
>40	Morbid obese

BMI: Body mass index

Table 2: Anthropometric variables

Variables	Group I (controls)	Group II (obese)
Age (years)	31±5.2	35±6.0
BMI (kg/m^2)	22.9±1.0	37.24±5.10

BMI: Body mass index

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

Variables	Group I (controls)	Group II (obese)	*P*
Resting HR	78.40±6.70	83±7.90	0.001
30:15 ratio	1.31±3.6	1.05±0.62	0.598 NS
Valsalva ratio	1.48±0.31	1.34±0.17	0.0041
S:L ratio	1.39±0.74	1.040±0.19	0.0010

NS: Non-significant, HR: Heart rate, S: L: Standing to lying

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

Variables	Group I (controls)	Group II (obese)	*P*
CPT SBP	10.43±5.7	7.07±4.72	0.001
CPT DBP	9.4±3.2	7.5±3.8	0.005
IHG SBP	12.9±2.35	9.0±4.9	0.0001

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, CPT: Cold-pressor test, IHG: Handgrip exercise

DISCUSSION

The results of the present study showed that the resting heart rate, Valsalva ratio, and S:L ratio in obese subjects were significantly lower as compared to the control group which indicates decrease in parasympathetic nerve function. Similarly, findings of CPTs both systolic and diastolic and findings of IHG tests were significantly lower in study group as compared to the control group which indicates decrease in sympathetic nerve function.

Obese group is less responsive to BP changes in response to autonomic function tests. Similar results were shown by some other investigators.[13,14] There was less increase of BP response to CPT in the obese people in contrast to the control group. A lesser increase in the BP after the cold water immersion points toward sympathetic insufficiency in obese subjects.[15] In another study, obese children possessed a decreased sympathetic and parasympathetic activity.[16,17]

However, our findings are inconsistent with those of Laederach-Hofmann *et al.*,[4] who found no overstimulation with increase in weight, but on the contrary observed a depression in the sympathetic and parasympathetic activity. Another study by Sheema and Malipatil[18] using heart rate variability test demonstrated increased sympathetic activity in obese individuals. With a reduction of caloric intake, there can be a prompt and major decline in sympathetic activity, although an increase in sympathoadrenal activity has also been documented.[19,20]

Strengths and Limitations of the Study

This is a cohort study in which there is elaborate and comprehensive assessment of function of ANS in large number of normal weight and obese, otherwise healthy adults. In addition, only individuals with normal glucose levels were included in the study which helped to rule out a major factor which might have otherwise influenced our findings.

One limitation of the present study was the sample size. Studies with larger sample size will help to support the findings of this study.

CONCLUSION

ANS dysfunction observed in this study shows the possibility of obesity leading to the dysfunctioning of the peripheral autonomic nerves. Thus, obesity, a risk factor for health, and its complications can be coped with by diagnosing and treating ANS dysfunction.

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REFERENCES

1. David OE. Obesity Part 1: Epidemiology, etiology, pathophysiology and non pharmacotherapeutic treatments. Internet J Acad Phys Assist 1997;2:1-27.
2. Landsberg L, Young JB. The role of the sympathoadrenal system in modulating energy expenditure. Clin Endocrinol Metab 1984;13:475-99.
3. Bray GA. Integration of energy intake and expenditure in animals and man: The autonomic and adrenal hypothesis. Clin Endocrinol Metab 1984;13:521-46.
4. Laederach-Hofmann K, Mussgay L, Rúddel H. Autonomic cardiovascular regulation in obesity. J Endocrinol 2000;164:59-66.
5. Sztajzel J, Golay A, Makoundou V, Lehmann TN, Barthassat V, Sievert K, *et al*. Impact of body fat mass extent on cardiac autonomic alterations in women. Eur J Clin Invest

2009;39:649-56.
6. Ito H, Ohshima A, Tsuzuki M, Ohto N, Yanagawa M, Maruyama T, *et al*. Effects of increased physical activity and mild calorie restriction on heart rate variability in obese women. Jpn Heart J 2001;42:459-69.
7. Ashida T, Ono C, Sugiyama T. Effects of short-term hypocaloric diet on sympatho-vagal interaction assessed by spectral analysis of heart rate and blood pressure variability during stress tests in obese hypertensive patients. Hypertens Res 2007;30:1199-203.
8. Spraul M, Ravussin E, Fontvieille AM, Rising R, Larson DE and Anderson EA. Reduced sympathetic nervous activity. A potential mechanism predisposing to body weight gain. J Clin Intest 1193;92:1730-5.
9. Grassi G, Seravalle G, Colombo M, Bolla G, Cattaneo BM, Cavagnini F, *et al.* Body weight reduction, sympathetic nerve traffic, and arterial baroreflex in obese normotensive humans. Circulation 1998;97:2037-42.
10. Snitker S, Macdonald I, Ravussin E, Astrup A. The sympathetic nervous system and obesity: Role in aetiology and treatment. Obes Rev 2000;1:5-15.
11. Laitinen T, Lindström J, Eriksson J, Ilanne-Parikka P, Aunola S, Keinänen-Kiukaanniemi S, *et al.* Cardiovascular autonomic dysfunction is associated with central obesity in persons with impaired glucose tolerance. Diabet Med 2011;28:699-704.
12. Noronha JL, Bhandarkar SD, Shenoy PN, Retnam VJ. Autonomic neuropathy in diabetes mellitus. J Postgrad Med 1981;27:1-6.
13. Emdin M, Gastaldelli A, Muscelli E, Macerata A, Natali A, Camastra S, *et al*. Hyperinsulinemia and autonomic nervous system dysfunction in obesity: Effect of weight loss. Circulation 2001;103:513-9.
14. Valensi P, Lormeau B, Dabbech M, Miossec P, Paries J, Dauchy F. Glucose induced thermogenesis, inhibition of lipid oxidation rate and autonomic dysfunction in nondiabetic obese women. Int J Obes 1998;22:494-9.
15. LeBlanc J, Dulac S, Cote J, Girard B. Autonomic nervous system and adaption to cold in man. J Appl Physiol 1975;39:181-6.
16. Nagai N, Matsumoto T, Kita H, Moritani T. Autonomic nervous system activity and the state and development of obesity in Japanese school children. Obes Res 2003;11:25-32.
17. Yakinci C, Mungen B, Karabiber H, Tayfun M, Evereklioglu C. Autonomic nervous system functions in obese children. Brain Dev 2000;22:151-3.
18. Sheema UK, Malipatil BS. A cross-sectional study on effect of body mass index on the spectral analysis of heart rate variability. Natl J Physiol Pharm Pharmacol 2015;5:250-2.
19. O'Dea K, Esler M, Leonard P, Stockigt JR, Nestel P. Noradrenaline turnover during under-and over-eating in normal weight subjects. Metabolism 1982;31:896-9.
20. Young JB, Landsberg L. Catecholamines and intermediary metabolism. Clin Endocrinol Metab 1977;6:599-631.

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