DOI: 10.5958/j.2319-5886.2.4.120

International Journal of Medical Research & Health Sciences

www.ijmrhs.com Volume 2 Issue 4 Oct-Dec Coden: IJMRHS Copyright @2013 ISSN: 2319-5886

Received: 20th July 2013 Revised: 10th Aug 2013 Accepted: 20th Aug 2013

Research article

A STUDY OF AUTONOMIC FUNCTION TESTS IN OBESE PEOPLE

*Rinku Garg[1], Varun Malhotra[2], Neera Goel[3], Usha Dhar[2], Yogesh Tripathi[2]

[1]Assistant Professor, [2]Professor, [3]Assistant Professor, Department of Physiology, Santosh Medical College, Ghaziabad, India

*Corresponding author email: rgrinkigarg6@gmail.com

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 health[1]. Obesity is a common and significant health hazard[2.] At an individual level, an excess of energy intake and an inadequacy of energy expenditure is thought to explain most cases of obesity[3,4]. A complex interaction among different factors like endocrine, nervous, metabolic factors maintains constant energy storage[5]. Obesity is considered to be a risk factor for a variety of cardiovascular conditions like hypertension, ischemic heart disease and stroke[3] and is characterized by hemodynamic and metabolic alterations[6].

Autonomic nervous system is a centre for the coordination of different body system[7]. Since the ANS is involved in energy metabolism and in the regulation of the cardiovascular system[8-10], 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[7]. Laitinen et al[11] 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 between18.5-24.9.Informed consent was taken from all the subjects. Subjects with age above 40years, 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 0.1cm. 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 (m^2)] [12]

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

Group I-Control group with BMI 18.5-24.9kg/m^2

Group II-Study group with BMI >30kg/m^2

Table 1: WHO Classification of BMI[13]

BMI	Category
<18.5	Underweight
18.5-24.9	Healthy
25-29.9	Overweight
30-39.9	Obese
>40	Morbid obese

The following autonomic function tests were performed:

For Assessing Parasympathetic Activity

1. **Resting heart rate** was calculated from ECG by using standard limb leads[14].
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. [15]
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[16].
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)[17]
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[18].

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 Kortk off 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[19].

Cold Pressor Test: After recording basal blood pressure, subjects were asked to dip left arm in the cold water (temp at 2-4^0 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[20].**Statistical Analysis**: Results were analysed by ANOVA with SPSS version 17.0 using an unpaired't' test

RESULTS

Table.2: Anthropometric variables

Variables	Group I(Controls)	Group II(Obese)
Age(yrs)	33.08±4.8	32.12±5.4
Height(mts)	1.62±0.42	1.51±0.56
Weight(kgs)	58.11±4.3	81.13±4.9
BMI(kg/m^2)	22.11±1.04	35.13±2.08

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

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

* p<0.05 versus group I

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

Variables	Group I(BMI 18.5-24.9)	Group II(BMI >30)	P value
IHG SBP	12.2±1.2	8.3±1.3	<0.05
IHG DBP	12.1±1.4	8.1±1.2	<0.05
CPT SBP	12.2±1.6	8.2±1.4	<0.05
CPT DBP	13.1±1.8	9.1±1.4	<0.05

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).

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 valsalva ratio, heart rate response to deep breathing and heart rate response to standing (30:15) in obese subjects were significantly lower 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[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[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[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 system25 or to a lower increase in peripheral resistance to manoeuvres activating sympathetic system[26]. Baek et al[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[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[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[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[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.

ACKNOWLEDGMENT

The authors are thankful to Dr. R K Arya, Professor & HOD, Department of Community Medicine, for his help in statistics. We are also thankful to subjects and all the technical staff for their contribution in the completion of the project.

Conflict of Interest: Nil

REFERENCES

1. Haslam DW, James WP. Obesity. Lancet 2005;366(9492):1197-209.

2. Simran G, Vidushi G. Effect of obesity on autonomic nervous system. Int J Cur Bio Med Sci 2011;1(12):15-18.
3. Esler M, Straznicky N, Eikelis N, Masuo K, Lambert G. Mechanism of sympathetic activity in obesity-related hypertension. Hypertension.2006;48:787
4. Lau DC, Douketis JD, Morrison KM, Hramaik IM, Sharma AM, Ur E.2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children summary. CMAJ 2007;176(8):S1-13.
5. Valensi P, Thi BN, Lormeau B, Paries J, Attali JR. Cardiac autonomic dysfunction in obese patients. Int J Obes Relat Metab Disord 1995;19(2): 113-18.
6. Colak R, Donder E, Karaoglu A, Ayhan O, Yalniz A. Obesity and the activity of autonomic nervous system. Turk J Med Sci 2000;30:173-76.
7. Bray GA. Autonomic and endocrine balance in the regulation of energy balance. Fed Proc 1986;45:1404-10.
8. Landsberg L, Young JB. The role of the sympathoadrenal system in modulating energy expenditure. Clin Endocrinol Metab 1984; 13:475-99.
9. Bray GA. Integration of energy intake and expenditure in animals and man: the autonomic and adrenal hypothesis. Clin Endocrinol Metab 1984; 13: 521-46.
10. Peterson HR, Rothschild M, Weinberg CR, Fell RD, McLeish KR, Pfeifer MA. Body fat and the activity of the autonomic nervous system. N Engl J Med 1988; 28: 1077-83.
11. Laitinen T. Cardiovascular autonomic dysfunction is associated with central obesity in persons with impaired glucose tolerance. Diabet Med 2011;28(6) 699-704.
12. Harrison. Biology of obesity. In: Harrison Principles of Internal Medicine. 17th ed. McGraw Hill;2008.P.462-67.
13. Hilsted J, Jenson SB. A simple test for autonomic neuropathy in juvenile diabetes. Acta Med Scand 1979;205:385-87.
14. WHO. Obesity: Preventing and managing the global epidemic: Report of the WHO consultation of obesity. Geneva:World Health Organisation 1998.
15. Page MM, Watkins PJ. The heart in diabetes:autonomic neuropathy and cardiomyopathy. Clin Endocrinol Metabol 1977;6:377-88.
16. Rodrigues EA, Ewing DJ. Immediate heart rate response to lying down: simple test for cardiac parasympathetic damage in diabetes.Br Med J 1983;800:287-9.
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.
18. Mathias CJ and Bannister R. Autonomic failure. A Textbook of Clinical Disorders of the Autonomic Nervous System.3rd ed. Newyork: Oxford University Press;1992.
19. Ewing DJ, Irwing JB, Kerr F, Wildsmith JAW, Clarke RF, Cardiovascular response to sustained handgrip in normal subjects and in patients with diabetes mellitus: a test of autonomic function. Clin Sci Mol Med 1974;46:295-306.
20. LeBlanc J, Dulac S, Cote J, Girard B. Autonomic nervous system and adaption to cold in man. J App Physiol 1975;39(2):181-6.
21. Emdin M, Gastaldelli A, Muscelli E, Macerata A, Natali A, Camastra S and Ferrannini E. Hyperinsulinemia and autonomic nervous system dysfunction in obesity: Effect of weight loss.Circulation.2001;103:513-19.
22. Valensi P, Lormeau B, Dabbech M, Miossec P, Paries J, Dauchy F. Glucose induced thermogenesis, inhibition of lipid oxidation rate and autonomic dysfunction in non-diabetic obese women. Int J Obes.1998;22:494-499.

23. Borne PVD, Hausberg M, Hoffman RP, Mark AL and Anderson EA. Hyperinsulinaemia produces cardiac vagal withdrawl and nonuniform sympathetic activation in normal subjects. Am J Physiol Regul Integr Comp Physiol 1999;276:178-183.
24. Monteiro G, Chathoth V,K Kishan. Cardiac autonomic response during a cold pressor test in normal and overweight adults. International Journal of Biomedical and Advance Research 2012;3(6):514-516.
25. Nageshwari K, Rajeev S and Divyanshoo RK. Assessment of respiratory and sympathetic cardiovascular parameters in obese school children. Ind J Physiol Pharmaco 2007;51(3):235-43.
26. Valensi P, Bich Ngoc PT, Idriss S, Paries J, Cazes P, Lormeauet B et al. Haemodynamic response to an isometric exercise test in obese patients. Influence of autonomic dysfunction. Int J of Obesity 1999;23:543-49.
27. Baeks MA Van. The peripheral sympathetic nervous system in human obesity. J Endocrinol 2000;164:59-66.
28. Akhter S, Begum N, Ferdousi S, Khan SM. Autonomoc neuropathy in obesity. J Bangladesh Soc Physiol 2011;6(1):5-9.
29. Velasco M, Gomez J, Blanco M, Rodriguez I. The cold pressor test: pharmacological and therapeutic aspects. American Journal of Therapeutics 1997;4(1):34-38.
30. Rinku Garg, Yogesh Tripathi, Varun Malhotra. Sympathetic Reactivity to Cold Pressor Test in Medical Students of Hypertensive and Normotensive Parents. International Journal of current research and review 2012;4(18):89-94.