CARDIOVASCULAR RESPONSE TO ISOMETRIC HANDGRIP EXERCICE TEST IN OBESE AND NORMAL WEIGHT YOUNG ADULTS

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ABSTRACT

Aim: To assess the cardiovascular sympathetic activity in obese and normal weight young adults by recording Heart rate, QT interval and Blood pressure.
Objectives: The study was undertaken to assess the effect of isometric handgrip exercise test on Heart rate, QT interval and Blood pressure (SBP & DBP) levels in obese and normal weight subjects.
Results: Baseline recording showed statistically significant prolonged QT interval and higher blood pressure level in obese in comparison with normal weight group (p=0.001, p=0.001 respectively). The response to exercise test varied among the groups. The obese group showed significant decline in QT interval (p=0.002) and normal weight group showed significant rise in blood pressure (p=0.001).
Conclusion: There is increased sympathetic activity, which is an important determinant of prolonged QT interval and elevated blood pressure in obesity. QT interval analysis is a cost-effective investigation in obese subjects who should receive a special medical attention.

Keywords: Obesity; QT interval; Blood pressure

1. INTRODUCTION

The maintenance of an adequate body weight is a major determinant of the survival and fitness of most of the higher organisms including human beings. In human adults, there are mechanisms that tend to maintain energy intake and energy expenditure in balance. There is preponderant evidence for the existence of an adipose tissue mass which can control with signals that come in part from adipose tissue and that act on hypothalamic receptors with effectors in the autonomic nervous system[1].

Obesity is abnormal or excessive fat accumulation that represents a major risk factor for a number of cardiovascular diseases (CVD) such as, Hypertension, Coronary heart disease and Cardiac arrhythmias[2]. Obesity is a disorder of energy balance affecting a wide range of people. Obesity is a cause for acquired long QT syndrome in otherwise healthy individuals is rapidly gaining attention of scientific community. QT interval represents ventricular depolarization and repolarization. Obesity has been proposed as a risk factor for ventricular arrhythmias and sudden death. Prevalence of obesity is increasing in children and adults as reflected in various studies[3]. Obesity is associated with increased sympathetic activity and is the leading risk factor for development of hypertension[4]. There is a positive association between obesity, left ventricular hypertrophy and hypertension. Heart rate and Blood pressure is regulated by the autonomic nervous system[5].The innervations of all tissues in our body other than skeletal muscle is by way of autonomic nervous system.

Exercise is a kind of physical stress and to some degree is an important activity in day to day life. Depending on the type of

physical exercise carried out, it will influence the heart rate and blood pressure response. Following isometric hand grip exercise test in normal healthy subjects there will be increase in heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP). However, not much data is available on sympathetic cardiovascular functions in obese young adults of India. Hence, the present study is undertaken to assess and compare the cardiovascular responses to isometric handgrip exercise test in obese and normal weight young adults.

1.1 Aims & Objectives

1) To compare the baseline HR, QT interval, SBP and DBP levels in obese and normal weight subjects
2) To assess the Heart rate, QT interval, Systolic Blood pressure and Diastolic Blood pressure response to isometric handgrip exercise test in obese and normal weight subjects.

2. MATERIALS AND METHODS

All the medical students studying in Phase I and Phase II of MBBS within the age group of 18-22 years in JSS Medical College were screened for the study. The students were given questionnaire/personal data form, which they were asked to fill up with certain details like dietary habits, extent of physical activity, family history etc. Clinical examination was conducted on all the subjects to rule out systemic disorders. The weight was measured to the nearest 0.5 kg and the height was measured without shoes to the nearest 0.5 cm.

The height in metres and weight in kilograms of each participant was recorded. Body mass index (BMI) was calculated by the formula[6],

$$\text{Body mass index} = \frac{\text{Weight in kilograms}}{\text{Height in meters square}}$$

The waist circumference was taken in centimetres at the midway between lower rib cage and anterior superior iliac spine at the end of normal expiration[7].

Depending on BMI and waist circumference (WC), the subjects were divided into two groups:

1. Obese group (30 male medical students) with BMI 27.5-32.5kg/m^2 and Waist circumference >90cm.
2. Normal weight group (30male medical students) with BMI 18.5-22.5kg/m^2 and Waist circumference <90cm.

This sample size was estimated enough to detect clinically relevant difference of 10% in parameters under study at 5% level of significance with 80% power. The study protocol was approved by ethical committee of JSS Medical College Mysore. Subjects were informed about the purpose of the study and informed consent was obtained. The study was done in the human experiment laboratory between 4pm-6pm in the department of physiology JSSMC, Mysore.

2.1 Procedure: Informed consent was obtained from all the subjects. The subjects were made to rest for 10minutes before recording their baseline Heart rate,QT interval, Systolic and Diastolic blood pressure.Heart rate and QT interval were recorded by using AD instruments Power lab instrument with Lab chart 7 version. Lead II ECG was taken for 5minutes. For each subject, two recordings of blood pressure were taken from which the average baseline Blood pressure (SBP & DBP) was obtained.

The subjects were explained through self-demonstration by the investigators about the Isometric hand grip exercise test.Subjects with their dominant hand were asked to exercise Maximum Voluntary Contraction (MVC) by gripping the handgrip dynamometer, as hard as possible for few seconds. The maximum force exerted was noted down.

After giving rest for 5 minutes, the subjects were asked to perform isometric handgrip exercise at 30% of their maximal voluntary contraction (MVC) with their dominant hand to the point of fatigue in sitting posture. During the test subjects were instructed to breathe normally and to

avoid performance of a valsalva manoeuvre. Immediately after the exercise test (within 30sec) Heart rate, QT interval and Blood Pressure were recorded.

2.2. Statistical methods

1. Mean and S.D.(standard deviation) of the Heart rate, QT interval, Systolic and Diastolic blood pressure were worked out, before and after session of isometric handgrip exercise test, for both groups.
2. Independent sample‘t’ test was applied using SPSS for windows (version18) for data analysis. The ‘p’ value less than 0.05 was considered statistically significant.
3. **Results:** The present study included 60 subjects; the characteristics of the two groups are shown in Table I.

There was no significant statistical difference in Heart rate between the two groups. The baseline mean ± S.D. value of QT interval, SBP and DBP were higher in obese group when compared to normal weight group, as shown in table II & III. These differences were statistically significant. The BMI, SBP and DBP were positively associated as shown in Figure 1 & 2.

3.1 After Isometric Exercise Test: The response to exercise test varied among the groups. The response to exercise test showed significant decline in QT interval in obese group when compared to normal weight group, as shown in table II. The increase in SBP and DBP in response to isometric handgrip exercise test was lower in Obese group when compared to Normal weight group as shown in table III. This was also statistically significant.

Table I. The characteristics of the two groups

	Obese	**Normal weight**
Number of subjects	30	30
Age (Mean±S.D)	18±1.07	18.43±0.63
Sex	Male	Male
BMI(Mean±S.D)	29.79±1.91kg/m^2	21.22±1.30kg/m^2
Waist circumference (Mean±S.D)	95.97±7.60	79.3±7.99cm

Table II. Mean & S.D. values of Heart rate, QT interval pre and post exercise test in obese and normal weight group

	Groups	**Mean±S.D.**	**‘p’value**
Heart rate(pre)	Obese Normal	75.5±9.14 79.5±9.38	0.102
QT interval (pre)	Obese Normal	0.343±0.025 0.306±0.92	0.001*
Heart rate(post)	Obese Normal	76.5±9.38 80.33±9.02	0.124
QT interval (post)	Obese Normal	0.322±0.02 0.299±0.028	0.002*

***‘p’ value <0.05, statistically significant**

Table III. Mean & S.D. values of SBP, DBP pre and post exercise test in obese and normal weight group

	Group	Mean±S.D.	'p'value
SBP(pre)	Obese Normal	125.26±8.99 111.40±8.93	0.001*
DBP(pre)	Obese Normal	79.80±5.15 70.60±6.01	0.001*
SBP(post)	Obese Normal	130.46±8.43 120.33±10.09	0.001*
DBP(post)	Obese Normal	83.60±4.91 76.93±6.11	0.001*

*** 'p' value <0.05, statistically significant**

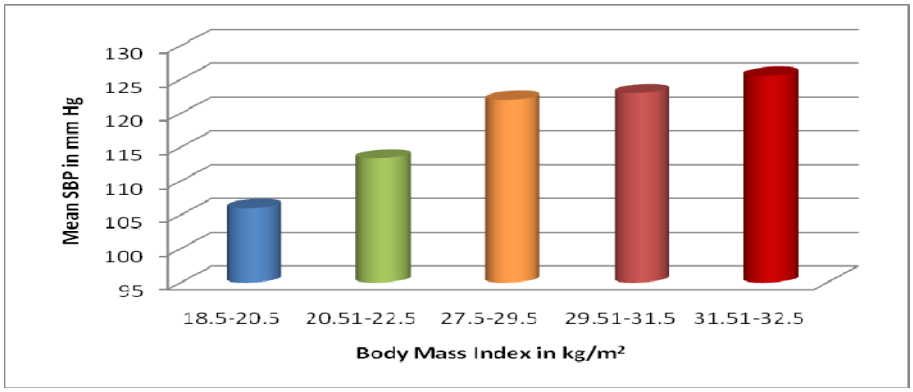

Fig1. Graph of mean Systolic Blood Pressure and Body Mass Index before exercise test.

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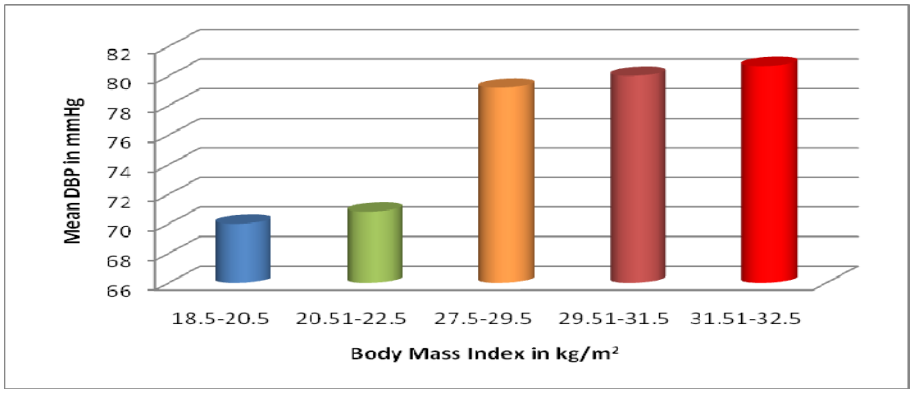

Fig2. Graph of mean Diastolic Blood Pressure and Body Mass Index before exercise test.

4. Discussion

The BMI and WC of obese group was higher when compared to normal group as shown in Table (I).Waist circumference has been reported to be a better index of android obesity than waist to hip ratio (WHR).Waist circumference not only correlates better with visceral adipose tissue, but also it is better related to the metabolic variables known to be associated with cardiovascular risk[7] (such as serum lipid and glucose levels l).

The cut-off value for normal BMI for Asian Indian men and women is 23 kg/m^2. The cut-off values for BMI and WC are lower in Asian Indians compared with the corresponding values in white populations[8].

In obesity, increased cardiac output observed with weight gain is due to additional blood flow required for the extra adipose tissue. Sustained and prolonged hemodynamic burden is required to induce structural changes in left ventricle as it happens in long standing obesity[2].

It can be hypothesised that higher baseline SBP,DBP in obese could be due to higher vasoconstrictor tone and increase in cardiac output due to increased load on heart, as a consequence of increased Body mass index. Part of increased cardiac output observed with weight gain is due to additional blood flow required for the extra adipose tissue. Sympathetic activation contributes to higher blood pressure level in obese group[4].

Sympathetic activation raises blood pressure and causes sodium and water retention in obesity mainly via renal nerves. Activation of renin-angiotensin system causes the fluid retention and increased blood volume. Renal sympathetic nerve mediates sodium retention and hypertension in obesity. Mechanism involved in sympathetic activation and high blood pressure levels in obesity is when the renal afferent nerves are stimulated by increased intra renal pressure and subsequent activation of renal mechanoreceptors, leading to renin-angiotensin-aldosterone system activation, hyperinsulinemia, fatty acids, Angiotensin II and hyperleptinemia[9]

There is a strong relationship between leptin, abdominal obesity with increased CVD risk. The mechanisms behind this inter-relationship will provide insight into the heterogeneous nature of obesity and the pathogenesis of CVD. Potentially, dysregulation of these parameters may account for the increased risk of CVD in Asian Indians[10,11]. Results of a study show that the relationship between percent body fat and BMI is different among different ethnic groups[12]. The Asian Indians have got higher body fat content compared to Americans due to difference in body build and energy balance.

It is now clear that white fat depots are not inert lumps but are actually endocrine tissues that secrete not only Leptin, but also other hormones like adipokines that affect fat metabolism. In addition, to these advances, there has also been a revolution in our understanding of neuroendocrine mechanisms regulating appetite, metabolism, and adiposity since the discovery of leptin just 15 years ago. If these advances soon translate into safe and effective pharmacological treatment of obesity, this would also greatly impact the management of obesity-hypertension[4].

Proposed mechanisms for long QT syndrome (LQTS) are the QT interval is influenced by autonomic tone, LQTS results from an imbalance in cardiac sympathetic innervation with either an over activity of left sided adrenergic nerves or an under activity of right sided nerves[13]. Autonomic system imbalance and autonomic neuropathy, mutations of genes affecting cardiac ion channels involved in cardiac repolarization, nonconducting scar tissue resulting from myocardial infarction, high glucose level, elevated insulin level, hypokalemia, obesity , and ventricular hypertrophy[14]. All the above changes mentioned are usually present in long standing obesity leading to prolonged QT interval. Prolonged QT interval in obesity is associated with the generation of life-threatening rhythm disturbances.

Evaluation of circulatory alterations during sustained isometric muscle contractions is a useful method to assess cardiac function[15]. During handgrip dynamometer exercise test, the literature mentions, in normal healthy persons sympathetic system gets activated leading to

1) Activation in cardiac sympathetic fibres causing increase in heart rate

dependent increase in cardiac output and blood pressure

2) Activation of peripheral sympathetic fibres to blood vessels causing, vasoconstriction and resultant increase in total peripheral resistance.

The obese group showed a decreased response to isometric handgrip exercise test indicating there is cardiac sympathetic activity instability[3].The lower BP response in Obese group is more likely to be lower cardiac sympathetic activation or to a lower increase in peripheral vascular response to manoeuvres activating sympathetic system[16]. The derangements in sympathetic cardiovascular function in the form of prolonged QT interval, elevated baseline SBP, DBP and decrease in response to handgrip dynamometer exercise test in obese group points towards autonomic imbalance. This autonomic imbalance is a risk factor for CVD in obese Indians in later part of their life.

CONCLUSION

There is increased sympathetic activity, which is an important determinant of prolonged QT interval and elevated blood pressure in obesity. QT interval analysis is a cost-effective investigation in obese subjects who should receive a special medical attention. Sympathetic system could be targeted in the treatment of obesity associated hypertension.

REFERENCES

1. Eric je quier, Luc tappy. Regulation of Body Weight in Humans. Physiological reviews 1999; 79(2): 452-72.
2. Pontiroli AE, Pizzocri P, Saibene A, Girola A, Koprivec D and Fragasso G. Left ventricular hypertrophy and QT interval in obesity and hypertension: effects of weight loss and of normalisation of blood pressure. Int J of Obesity. 2004; 28: 1118-23.
3. 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.
4. Rahmouni K, Correic MLG, Haynes WG, Mark AL. Obesity associated hypertension: New Insights into Mechanism. Hypertension 2005; 45: 9-14.
5. William F. Ganong. Cardiovascular regulatory mechanisms. In: Ganong's Review of medical physiology. 23rd ed. New Delhi: TATA McGraw Hill; 2010. P. 555-68.
6. Harrison. Biology of obesity. In: Harrisons Principles of internal medicine. 17th ed. McGraw Hill; 2008. P. 462-67.
7. Sunita SK, Himanshu T, Srinivasan. Waist circumference correlates better with body mass index than waist to hip ratio in Asian Indians. Natl Med J India 2003; 16 (4): 189-92.
8. Snehalatha C, Viswanathan V, Ramachandran A. Cutoff values for normal anthropometric variables in Asian Indian adults. Diabetes Care. 2003, 26 (5): 1380-84.
9. Hall JE, Brands MW, Hildebrandt DA, Kuo J, Fitzgerald S. Role of sympathetic nervous sytem and neuropeptides in obesity hypertension. Braz J of Med Biol Res 2000 June; 33(6): 605-18.
10. Jessica Smith, Maha Al-Amri, Allan Sniderman, Katherine Cianflone. Leptin and adiponectin in relation to body fat percentage, waist to hip ratio and the apoB/apoA1 ratio in Asian Indian and Caucasian men and women**.** Nutrition & Metabolism 2006; 3: 18.
11. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004; 363(9403): 157-63.
12. Deurenberg P, Yap M, Stayeren WA. Body mass index and percent body fat: a meta analysis among different ethnic

groups.Int J Obes Relat Metab Disord 1998; 22(12): 1164-71.
13. Jayne BC. QTc is associated with obesity and physical activity level for African American females. JEP online 2004; 7(2): 16-24.
14. Jacqueline MD, Richard SC. Heart rate-corrected QT interval prolongation predicts risk of coronary heart disease in Black and White middle-aged men and women. J of Am Coll of Cardiol 2004; 43: 565-71.
15. Laird WP, Fixler DE, Huffines FD. Cardiovascular response to isometric exercise in normal adolescents. Circulation 1979; 59: 651-54.
16. 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.