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Original Article

Cardiovascular and Electrocardiography Changes in Obese Individuals at Rest and During Stress Test

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ABSTRACT

Background: The possible relation between obesity and cardiovascular disease (CVD) has been subject of great controversy. The relationship between the degree of obesity and incidence or CVD was stressed by study of obesity as an independent risk factor for CVD.

Objective: The objective of the study was to see the cardiovascular findings in obese individuals at rest and during treadmill stress testing (ST) (TMT) and to see the effort tolerance of obese individuals using TMT.

Methods: This study was conducted in tertiary care hospital during a period of 1 year and it included a total of 50 adult obese patients on the basis of criteria for obesity being body mass index of more than 30.

Result: Out of which 50 obese, 12 (24%) were positive for ischemic heart disease, 18 (36%) diabetic, 23 (46%) were chronic smoker, and 31 (62%) had hypercholesterolemia. The cardiovascular findings were tachycardia 9 (18%) and The ischemic response: Significant ST-segment depression was found in 9 (18%). All these findings suggested that left ventricular function was abnormal, and persons were prone to develop ischemic or infarction.

Conclusion: This study helps us to rehabilitate and educated the cases of obesity. The obesity associated with the presence of risk factors promotes the incidence of CVD. The incidence increases in obese individuals with multiple risk factors more as compared to those with single risk factors. Reduction of weight and control of risk factors such as diabetes, cholesterol, alcohol, and smoking may contribute to lower the incidence of CVD.

Key words: Body mass index, Cardiovascular, Electrocardiography, Obesity, Stress test

INTRODUCTION

Obesity is a common nutritional disorder in our societies. It significance requires constant emphasis because it is associated with increased mortality, predispose to the development of important diseases, and diminish the efficiency of those affected.

Excess deposition of adipose tissue is obesity. However, it is difficult to decide what should be labeled as excess. Comparison of weight (adjusted to height) with that of the mean derived from population studies can be taken as simple criteria.

In India, the table used may be those derived from the study of people because our average would be different from that of western countries.

Another set of average is derived from knowledge of the effect of weight on longevity. The range associated with highest life expectancy is called ideal weight.

Weight of persons 20% above the ideal weight substantially increases the rate of morbidity and mortality.

The incidence of obesity is proportional to the availability of food for excess consumption. Hence, the incidence of obesity would be higher in developed countries or among people belonging to higher economic strata in countries like India.

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The higher degree of health awareness may modify this statement.

Obesity usually is defined as the presence of an abnormally large amount of adipose tissue. When the amount adipose tissue is very large, the diagnosis is labeled "Morbid obesity."

Adipose tissue mass is difficult to measure clinically however and the precise cut off between normally and obesity has been a subject of debate in years.

The recent recognition that the pattern of distribution of adipose tissue throughout the body affects metabolic consequences and may be more important factor than total adipose tissue mass thus a person with fat located predominantly in the abdominal region may be at greater risk of hypertension, heart diseases, and diabetes mellitus than another individual with a greater total amount of adipose tissue that is located predominantly in gluteal region.

The National Institute of Health and Human Service, Public Health Services, 1998.

Determination of Body Fat and Its Distribution

There are several laboratory methods for measuring body fat, but none of these is widely available for clinical use.

Weight and Height

The most commonly anthropometric measure in obesity clinics and medical practice are weight and height. They have the advantages of wide availability of equipment, ease, and accuracy of use general acceptability to patients; in fact, the most patients define obesity on the basis of body weight. The basic problem with these measures is that body weight is strongly correlated with body height and for this reason, not a good measure of body fat.

Studies have shown that the body mass index (BMI) related closely to body fat while being quite independent of height.

Gossow and Webster recently have suggested that the BMI actually is a measure of body fat related to height rather than percent of body and that this is better measure of obesity than percentage body fat.

Although the calculation of BMI is more complex than that of relative weight, its interpretation possibly is simpler once BMI is calculated; therefore, it can be related to a single set of easily memorized standards. For this reason, as well as its strong correlation with body fatness and increasing use of epidemiological studies, recommend the routine use of BMI.

Simple measurement of weight does not give very useful information. If weight is adjusted to height and age and compared with desirable weight derived from longitudinal population. Studies it can give a very good idea about obesity.

Individual with 20% above the ideal weight can be diagnosed as obese.

Obesity exists when adipose tissue makes up greater than "Normal" fraction of total body weight. In male subjects aged 8 years, approximately 15-18% of body weight is fat.

The corresponding figures for females are 20-25%.

The percentage of body weight that is fat usually increases with age this may not be necessary or desirable.

Body fat content >28% of total body weight for men and >30% for women is obesity." The problem with this definition is that body fat is difficult TU measure in the clinical setting.

MATERIALS AND METHODS

This study is conducted in Department of General Medicine, Tertiary Care Hospital in Mumbai during a period of 1 year. This study included a total of 50 obese patients.

Criteria for Selection of Patients

I. On the basis of criteria for obesity being BMI more than 30.
2. Obese individuals of age between 20 to 70 years were selected.

Exclusion Criteria

Contraindication to stress testing (ST) and conditions which could interfere with results, patients belonging to these groups is excluded from the study:

1. History of recent myocardial infarction (in last 6 months)
2. Presence of signs and symptoms of CCF
3. Fresh changes in ECG
4. Hypertension
5. Various conduction block
6. Any congenital heart disease
7. Suspected cases of ventricular aneurysm
8. Myocarditis, pericarditis, pericardia! effusion
9. Chronic corpulmonale
10. Severe anemia (Hb <5 g %)
11. Acute noncardiac illnesses
12. Musculoskeletal abnormalities.

Method

A total of 50 obese individuals were included in the study. A pro forma was prepared which included detailed history, clinical examination, and requisite investigations.

RESULTS

This study is conducted in Department of General Medicine, Tertiary Care Hospital in Mumbai. This study included a total of 50 obese patients (Tables 1-14).

DISCUSSION

Obesity is an independent risk factor for cardiovascular disease (CVD). This relationship between degree of obesity and the incidence of CVD has been proved by many studies. This relation was reexamined in male and female of original Framingham Cohort, recent observation of disease occurrence over 26 years indicate that obesity is a significant independent predictor of CVD.[32]

Obesity is directly related to an increased risk profile for atherogenesis, i.e., it has been associated with increased blood pressure, hyperlipidemia, glucose intolerance, and hyperinsulinemia.[46]

Obesity increases the work done by heart which enlarges with rising body weight. Cardiac output, stroke volume and blood volume all increases. Hypertension is also common. It is difficult to separate the contribution of obesity from that of other risk factors such as diabetes, hypertension, hyperlipidemia, smoking, alcohol, and physical inactivity.

Keeping the above facts in view a study of cardiovascular and ECG findings in obese at rest and using tread mill ST (TMT) has been done in the Department of General Medicine, Tertiary Care Hospital, Mumbai.

Although it was decided to select the cases from groups with other risk factors and without other risk factors, in spite of our meticulous efforts, we could not find any single obese individual having no other risk factor hence results of other studies assessing effort of risk factors other than obesity on incidence of heart disease were reviewed and compared with our study.

Age and Sex Incidence in Obese

In our study, a total number of 50 obese individuals have been selected with criteria of BMI more than 30.

Out of total 50 cases, 34 (68%) obese were male and 16 (32%) were female.

Table 1: Classification of weight status: 1

Parameter	BMI (kg/m²)	Risk of comorbidities
Underweight	<18.5	Low
Healthy weight	18.5-24.9	Average
Overweight	25.0-29.9	Increased
Obesity class 1	30.0-34.9	Moderate
Obesity class 2	35.0-39.9	Severe
Obesity class 3	-≥40	Very severe

Obesity: Preventing and managing the global epidemic, 2000, WHO, Geneva, BMI: Body mass index

Table 2: Age-wise distribution of obese individuals

Age group	Male	Female	Total (%)
20-30	1	0	1 (2)
31-40	10	6	16 (32)
41-50	16	9	25 (50)
51-60	6	1	7 (14)
61-70	1	0	1 (2)
Total	34	16	50

Table 3: Sex-wise distribution of obese individuals

Total obese individual	Total male obese	Total female obese
50	34	16

Table 4: BMI of obese individuals

Number of cases (%)	BMI
48 (96)	30-39 (Obese)
2 (4)	40 and above grossly obese

BMI: Body mass index

Table 5: Percentage of different risk factors in obese individual male and female

Risk factor	Number of case (%)
Old IHD	12 (24)
Diabetes Mellitus	18 (36)
Smoking	29 (58)
Alcohol	18 (36)
Cholesterol	31 (62)

Table 6: Abnormal cardiovascular findings in obese individuals at rest

Abnormal cardiovascular findings	Total cases (%)
Bradycardia	-
Tachycardia	9 (18)
Murmurs systolic (Functional)	3 (6)
Hypotension	2 (4)

There were 41 (82 %) obese of age between 31-50 years. One obese was 22 years old and rest of 8 (16%) were of more than 51 years.

Table 7: Abnormal cardiovascular findings in obese individuals during TMT

Abnormal cardiovascular findings	Total Cases (%)
Bradycardia	-
Tachycardia	50 (100)
Murmurs systolic (functional)	-
Hypertensive response	46 (92)
Hypotensive response	400 (8)

TMT: Treadmill stress testing

Table 8: Cardiovascular status of obese individuals according to functional class

Stage or grade	Mets unit	Number of cases (%)	Functional class
Stage 0 (Warmup)	<3	10 (20)	IV
Stage I	4.8	18 (36)	III
Stage II	6.8	18 (36)	II
Stage III	9.6	2 (4)	I
Stage IV	13.2	2 (4)	I
Stage V	16.1	-	Normal
Total		50	

Table 9: Symptoms and signs during in obese individuals

Symptoms/signs	Number of cases (%)
Chest pain	2 (4)
Giddiness	6 (12)
Syncope	0 (0)
Leg cramps	5 (10)
Breathlessness	2 (4)
Arrhythmia	0 (0)
ST depression>_2 mm	9 (18)
Abnormal blood pressure response	4 (8)
Hypertensive	
Hypotensive	-
	4

TMT: Treadmill stress testing

Table 10: Results of and reasons for terminating the test

Reason for termination of test	Number of cases (%)
ST-T. changes (Ischemic response)	I I (22)
Achievement of 100% target heart rate	2 (4)
Development of symptoms and signs	10 (20)

TMT: Treadmill stress testing

These data are in the favor of the fact that obesity usually occur in the middle age.

Preble *et al.*[45] found the maximum incidence in the age group of 41-50 years.[45] Patel[43] found the maximum incidence in the age group of 31-40 years.[43]

Incidence of Ischemic Heart Disease (IHD) and Relation with Obesity

In this study, the incidence of IHD was total 25%. It is well-known fact that IHD incidence increases with weight

Table 11: Electrocardiographic findings in obese individuals at rest

ECG	Number of cases (%)
Heart rate	
Normal	41 (82)
Bradycardia	-
Tachycardia	9 (18)
Rhythm	
Normal	-
Heart block	
Atrial ectopia	
Ventricular ECT	5 (10)
Low voltage complex	12 (24)
ST. Segment depression	
A. Upsloping	
B. Downsloping	
C. Horizental	
Old myocardial	6 (12)
T wave abnormality	9 (18)
QTC prolongation	
LVH	6 (12)
LAD	4 (8)

LVH: Left ventricular hypertrophy, LAD: Left axis deviation, ECG: Electrocardiography

Table 12: Electrocardiographic during TMT

ECG	Number of cases (%)
Heart rate	
Normal	
Bradycardia	-
Tachycardia	50 (100)
Rhythm	
Normal	50 (100)
Heart block	
Atrial ectopia	
Ventricular ECT	5 (10)
ST. Segment depression	
A. Upsloping	9 (18)
B. Downsloping	6
C. Horizental	3
T wave abnormality	5 (4)

TMT: Tread mill stress testing, ECG: Electrocardiography

Table 13: Risk factors in 15 patients positive during TMT

Age (years)	Male	Female
31-40	2	2
41-50	4	1
51-60	3	3

TMT: Tread mill stress testing

Table 14: ST depression Chart

Parameter	ST depression	T WAVE abnormality	Hypotensive response
Diabetes	6	2	3
Smoking	5	1	0
Alcoholism	2	1	2
Hypercholesterolemia	6	2	2
Old IHD	2	0	2
LVH	2	2	1

ST: Stress testing, LVH: Left ventricular hypertrophy, IHD: Ischemic heart disease

of individual in the presence of risk factors. As the weight increases, the incidence of IHD also increases.

Keys *et al.*[5] say the relationship between the relative weight and of skin fold thickness to the 5 years incidence (632) cases of coronary heart disease was examined in man 40-59 years of age. At entry to the study United States Railroad man, 2439 men in Northern Europe and 6579 men in Southern Europe were studied of all men studied 22.3% had a BMI 27 or more at the entry and therefore were labeled as relatively heavy men. In this category, coronary heart disease was 29% of the Americans, 23.1 % of Southern Europe.[5]

Obesity and Diabetes

In this study, the incidence of diabetes was 37% and incidence of IHD in this group 73%.

Diabetes is a primary risk factor for incidence of increased atherosclerosis and IHD. From the Framingham study, Gordon *et al.*[31] in known diabetic, in both noninsulin-dependent diabetes mellitus (NIDDM) and IDDM, there is at least two-fold increase in incidence of coronary artery disease.[31]

Obesity and Hypercholesterolemia

Hypercholesterolemia is also a well-documented primary risk factor for coronary heart disease. When it is associated with other risk factors, it accounts for higher incidence. In this study, value of serum cholesterol is found to be high in 62% of total obese individual.

Obesity and Smoking

In this study, 29 obese individuals were chronic smokers. They all were giving the history of smoking for more than 10 years and I 0-15 sticks per day. Out of the above 40% of chronic smokers, the effort tolerance was poor in all cases and the positive response for IHD was present in 6 cases. It is well-known fact that smoking produces adverse effects on coronary vessels and if associated with other risk factor their incidence of coronary heart disease increases.

The frequency of episodes of ischemia was 3 times greater and duration of ischemia J 2 times longer in smokers than in nonsmokers. Barry *et al.* (1989).

The Cardiovascular and ECGs Findings in the Present Study was as Follows

In this study tachycardia in 9 cases (19%), remaining 41 individuals had normal pulse rate. During TMT, all obese had increased heart rate (normal response).

Hypotensive response in 4 (8%) individuals. There was functional murmur present in 3 individual at rest.

Electrocardiographic findings were corresponding with clinical cardiovascular findings in all obese individuals. In this study, 41 (82%) obese had normal heart rate and tachycardia was in 9 (19%) individuals.

Ventricular ectopics (VPC's) were present in 5 individuals.

Left axis deviation was present in 4 individuals. Left ventricular hypertrophy (LVH) in 6(12%) cases.

The finding of old typical myocardial infarction was present in 6 (12%) individuals. The finding of T-wave abnormality was present in 9 (18%) individuals.

St. Segment abnormality which was 0% at rest in obese individuals became 23% during ST.

Out of 15 obese individuals who were positive for IHD, 6 (12%) had down sloping type of depression (reported as strongly positive) and 3 (6%) had horizontal. VPC's disappeared in 5 individuals possibly due to overdrive suppression of impulse. In 2 obese individual, T-wave which was inverted at rest became positive during ST which was sign of ischemia and test was considered to be positive for IHD.

Franks *et al.*[27] have done statistical analysis of 1.029 electrocardiograms in obese subjects. The heart rate, PR-interval, QRS duration, QTc interval and voltage increase and QRS vector shifted to left with increasing obesity. These changes were independent of age, sex, and blood pressure. Bradycardia was present in 19% of patients but tachycardia in only 0.5%.[27]

The ST and T abnormalities were present in 2% correlating better with severity of obesity. The heart rate and QRS voltage increases with increasing obesity.

Wilson *et al.*[51] (1991) determined the relationship of regional fat distribution and obesity to electrocardiographic parameters in healthy premenopausal women.[51]

They found that intra-abdominal fat was significantly associated with prolongation of QTc interval and susceptibility of cardiac arrhythmia.[51]

In our study, we found that QTc prolongation was not seen.

An epidemiological study of urban population of Delhi (Chadha *et al.*[16]) was carried out in persons with history of obesity and hypertension and smoking. The obtained data form a sample of 13723 adults suggested that hypertension had strong association with obesity, diabetes, smoking, and family history were also found to be associated with IHD.[16]

In the TMT response in the present study, we found that a total of I 5 (30%) obese individuals were positive for IHD. There was depression of ST segment more than 2 mm. In 6 (12%) cases, there was strongly positive response for IHD.

In 3 (6%) obese individual, the ST segment depression was horizontal. Effort tolerance in all these individuals was impaired and poor. In 2 (4%) obese individuals, the effort tolerance was good and test was negative for exercise inducible ischemia and symptoms and signs were less significant and there was achievement of target heart rate (THR).

The point common in group which achieved THR was that they had only one additional risk factor, i.e., family history.

In 1 0, (20%), the reasons for terminating the test were development of symptoms and signs.

The effort tolerance was impaired in 46 (92%) which is common in obese individuals.

CONCLUSION

In this study, cardiovascular and ECG findings in obese individuals at rest and by using TMT were studied and recorded.

In our study, 50 obese individuals were selected with BMI more than 30 82% of obese individuals were in between 30 and 50 years of age. Out of which 50 obese, 12 (24%) were positive for IHD, 18 (36%) diabetic, 23 (46%) were chronic smoker, and 31 (62%) had hypercholesterolemia. The cardiovascular findings were tachycardia 9 (18%) and systolic murmur 3 (6%). When these cardiovascular findings were compared with ST, there was hypotensive response in 4 (8%).

The ischemic response: Significant ST segment depression was found in 9 (18%). All these findings suggested that left ventricular function was abnormal and persons were prone to develop ischemic or infarction.

The electrocardiographic findings were correlated with cardiovascular findings and changes occurred during ST.

The ventricular premature contractions were present in 5 (l0%) at rest and no VPC's during exercise. Disappearance of VPC's is likely to be due to overdrive suppression of ectopic impulses.

In resting ECG, the findings suggestive of LVH was found in 6 (12%) and old myocardial infarction in 6 (12%). T-wave abnormality in 9 (918%). T-wave which was inverted in resting ECG became positive during TMT in 2 cases which were suggestive of ischemia.

All bases persons were subjected for their serum cholesterol estimation and it was found to be significantly increased. There is strong evidence that IHD is common in obese individuals than persons having normal weight and height for that particular age, cholesterol may be an important common factor.

The effort tolerance was found to be very poor in 20% of obese individual in whom before producing ST changes during ST having sense of rotation, giddiness and heaviness or chest pain are also positive if they could have continued with exercise (inconclusive test).

This study helps us to rehabilitate and educated the cases of obesity.

The obesity associated with presence of risk factors promotes the incidence of CVD. The incidence increases in obese individuals with multiple risk factors more as compared to those with single risk factors.

Reduction of weight and control of risk factors such as diabetes, cholesterol, alcohol, and smoking may contribute to lower the incidence of CVDs.

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